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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. L. W. MARSHALL, Manager
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THE DANGERS OF SAILORS' KNIVES.

A number of accidents which have occurred recently to British fishing vessels have been attributed to the magnetized condition of the sheath-knives carried by the sailors. Iron, as is well known, is easily magnetized and may acquire considerable strength due only to the earth's field. If it be used anywhere near a dynamo or motor it is almost sure to become strongly magnetic. Now, it has recently been discovered that the sailors' knives may become magnetized so strongly as to influence considerably the ship's compass and that the wrecks referred to above have been brought about in this way. It has been suggested that the sailors be supplied with knives of non-magnetic material, when the danger will at once disappear. Here is an opportunity to revive the so-called "lost art of tempering copper."

AN UNPROMISING SCHEME.

During the presidential address of Dr. S. S. Wheeler before the American Institute of Electrical Engineers in Milwaukee recently, the speaker called the attention of those present to the duty of engineers to expose frauds and warn the public against undertakings of an impossible nature. It was rather a coincidence that the following advertisement appeared in a local paper the same morning:

> WANTED—A man that can back me for from $1,000 to $5,000 in making and perfecting a patent whereby electric power can be taken from the air to operate motors and dynamos. I feel that I have the correct idea and with capital to develop this machine we can revolutionize the entire power system now in use. The air is enormously charged with electricity and if Marconi with delicate machinery can force currents many miles through space, why not with powerful machinery collect these currents for driving power.

It is never possible to prove a negative, yet it is never wise to go into any work simply for this reason and without any knowledge whatever regarding the subject. The public can not be expected to know much about the electrical conditions of the atmosphere; in fact, it is true that we all are regrettably ignorant regarding this subject. Our present knowledge gives us no hope of accomplishing a feat of the kind suggested above. It is true that great differences in potential seem to exist between various parts of the atmosphere, but this does not indicate that a large amount of power is represented; in fact, when we ordinarily think of a stroke of lightning as representing an enormous power, we do not know that this is so. Indeed, during the discussion on one of the papers at the convention, Dr. C. P. Steinmetz expressed the opinion that the potential causing a long flash of lightning was probably measured in tens of thousands of volts and not in millions, as the length of the discharge would seem to indicate.

All evidence which has so far been collected does not point to the atmosphere as an inexhaustible source of electrical energy. But it is more important, from the investor's point of view, that before he puts his money into any such scheme as that suggested above he should have some evidence at least of the feasibility of the undertaking. Probably the most surprising development, to the layman at least, in recent years, is that of wireless telegraphy, yet before the beginnings of this art were made we knew that electrical waves could be sent through space; in other words, a large amount of work had been done by the scientist before any attempt at utilization could be made. The same has been true in the other arts; the same is true to-day of the proposal to utilize atmospheric electricity. We must know more about it; we must know that we can draw it down and that there is a supply large enough to make it worth while. When we know these things it will be time to ask for financial support.

CONDITIONS AFFECTING THE TRANSMISSION OF WIRELESS TELEGRAPHIC SIGNALS.

But little has been heard during the last year or two of the real progress which has been made in the art of wireless telegraphy; therefore the article by Professor Reginald A. Fessenden, appearing in the *Electrical Review* (London) for May 11, which deals with the work he has done, is very acceptable. Professor Fessenden has been conducting experiments in various parts of the world, notably across the Atlantic ocean between stations at Boston, Mass., and Machrihanish, Scotland. The distance between the latter two stations is some 3,000 miles, yet it seems that, under favorable conditions, messages can be exchanged easily and reliably. The work, however, has not consisted merely in the exchange of signals, but has been an attempt to study scientifically the conditions affecting transmission, with a view to improvement and increased reliability. The latter phase is exceedingly important, because the ability to send messages varies very greatly on different days and during different parts of the same day. Professor Fessenden has found that on certain days the signals received were 500 times more intense than those sent out under similar conditions on other days. This is an important fact, for it means that in order to be able to send messages without fail on any day a factor of safety, so to speak, of 500, or possibly more, will be necessary. This may be secured either by an increase in sensitiveness of the receiving apparatus or an increase in the power of the impulses sent out. Probably, in practice, both means will be adopted; but it does not seem likely that it will be sufficient to adopt a certain intensity of transmission known to be ample for the worst conditions and use this on all occasions, for when the conditions are favorable to transmission such intense signals would not only be unnecessary, but probably detrimental. They might not only affect the operation of stations other than the one for which they were intended, but they might even interfere with the latter itself, for Professor Fessenden has noticed during his tests across the Atlantic what he calls an echo signal—a signal coming about one-fifth of a second later than the main signal. For certain reasons he believes that this second signal reaches the receiving station by going the longer way around. Under conditions such that these echo signals were fairly intense, they probably would be rather troublesome at the receiving station. It would therefore seem necessary to test the transmission conditions frequently and use an intensity of signal only sufficient to ensure its reception. These changes in conditions affecting transmission may take place with some rapidity. Those due to the action of sunlight are known to be rapid. Therefore it will be necessary to make these tests at rather frequent intervals.

Besides the action of sunlight, which was pointed out some time ago, Professor Fessenden has found that there appear to be large masses of absorbing material in the atmosphere which considerably reduce the intensity of the signals. These absorbing masses may be larger or smaller and may exist at various heights. In the tropics they seem to be lower down, so that transmission there over long distances is more difficult than in the temperate zones. In fact, it is found that in some cases the absorption may be so great as to leave only about one-tenth per cent of the energy to effect the signals. If, as assumed, these absorbing masses are somewhat of the nature of clouds, they must be shifting about, and thus will cause changes in transmission conditions.

Another peculiar effect found is what has been called aeolotropic absorption. Messages at certain times have been found to be transmitted more easily in east and west directions than in north and south. At other times the transmission north and south is better. There are also indications that defraction takes place. These effects might be due to the shifting about of the absorbing masses referred to above.

It is such studies of wireless telegraphy that will place it upon a sure basis. Haphazard experiments, consisting merely of sending signals from point to point, do very little except to demonstrate that the signals can be sent. It is only when the conditions affecting transmission can be dealt with scientifically that any progress may be hoped for. It is evident from the work that has already been done that a wireless telegraph system, particularly if it operate over considerable distances, will require the services of a staff of trained specialists.

LIGHTNING PROTECTION.

"Protection from lightning is the one phase in the operation of an electrical power system which has not been brought under control." This was the statement which an operating engineer made during the discussion on lightning arresters which took place at the recent meeting of the American Institute of Electrical Engineers. This statement would certainly draw attention to the matter if it were necessary, but every year the subject comes up in one form or another. This year it was brought up by three papers devoted to the matter read at the above convention; and it was again brought up at the convention of the National Electric Light Association, held at Atlantic City, N. J., during the week just closed. Years ago one frequently heard the expression, "harnessed lightning," meaning, of course, electricity under control. This expression is seldom met with to-day, as the public is more accustomed to electrical applications, and the term "lightning" is now used by many engineers to mean specifically electrical energy which is not under control. This energy may have its origin outside of the electrical system or may be set loose in the system itself by local causes. While not all engineers are ready to class these latter phenomena as lightning, the term may be used until a better has been found, particularly as the means of preventing damage are much the same, irrespective of whether the uncontrolled energy has been set up outside or within the system.

The subject of lightning protection was brought up at the convention of the National Electric Light Association in the form of a committee report. This committee compiled statistics and secured statistics from members of the association covering the year 1905, and classified these and studied the results carefully. While these statistics are not complete enough and have not covered a sufficiently long period to lead to any definite conclusions, some interesting features were pointed out. The

first of these is the statement that two-thirds of the companies reporting have been practically free from trouble. As it is more probable that companies which had accidents from lightning reported than those which did not, it seems likely that the proportion would be still larger if all had replied to the enquiry. Looking at the situation from another light, it is significant that one-third of the companies did have unpleasant experiences from lightning.

The value of property destroyed by lightning was shown by the report to be small compared with the value of the plants. The usual damage is the destruction of a meter or of the lightning arrester itself, or the burning out of a transformer coil. In the first two cases the apparatus is comparatively inexpensive, and in the latter case the damage is often easily repaired; but the money value of the property destroyed is not a measure of the damage—the principal loss comes from interruptions to the service and from the uncertainty and uneasiness caused. A comforting feature is the decrease of this trouble each year, which is brought about by the use of improved apparatus of all kinds, and particularly by the replacing of older types of apparatus by more improved ones.

A striking feature of the situation was brought out by Dr. Steinmetz during the discussion at the Institute meeting. He said that the problem was first one of engineering, and that it should be one of the first to be taken up. Heretofore, electrical companies have been accustomed to running their lines wherever they pleased, and then endeavoring to protect them against lightning. When this process is followed they can not hope to be entirely successful. The method which should be pursued would be to survey the district through which the line must pass, looking for traces of lightning. Such evidences are sure to be found wherever thunderstorms occur, and they mark the points most exposed to the danger, and which should be avoided. Isolated hills and other unprotected localities are pretty sure to be dangerous places, and a transmission line should not go over them. Of course, this principle can not be followed strictly, for in the mountains the storms are likely to follow the valleys. But, in any case, when surveying the route for the line, this principle must be borne in mind, and the route least exposed should be followed.

Having obtained the most desirable route, the problem of protecting the system divides itself into two parts—that of protecting the apparatus in the stations and that of protecting the line. No one device can be expected to accomplish both results. To protect the line overhead with ground wires of fairly heavy cross-section and supplied with ground connections at short intervals seems to be the most satisfactory solution. Light wires, which are frequently used for this purpose, are not dependable. To protect the station apparatus some form of air-gap arrester seems to be preferred in this country. It is placed near the apparatus to be protected, and, by furnishing a point of weak insulation, allows a high-voltage discharge to break its way through to the ground; but the path once formed in this way may be taken by the generator current, and this is the cause of the destruction of the arrester. The great problem at this point is to provide an apparatus which will take care of the high-voltage discharge and which will be able to put out the arcs thus formed without being destroyed.

To protect the system from damage due to high voltages set up within it seems to be as difficult, if not more so, than to protect it from outside disturbances; but, fortunately, such troubles are rare.

THE ART OF INVENTING.

An interesting discussion took place at the recent convention of the American Institute of Electrical Engineers at Milwaukee, following the reading of a paper by Mr. Edwin J. Prindle, entitled "The Art of Inventing." There are really two phases of the subject. One is the simple invention of a novel device; the other, and the more important one, is its successful application. Not infrequently the two steps are made by one person, but perhaps more often the successful inventor, the one who does something immediately useful, is the man who takes old ideas and puts them to a practical use.

A very pretty illustration of an invention of the second kind was brought out in a paper read by Mr. Charles H. Bedell, dealing with the influence of the auxiliary pole on the design of direct-current motors. Now, the idea of using an auxiliary pole to assist in commutation is about fifteen years old. Any one glancing through some of the older text-books on electrical engineering will find it described in various forms, as proposed by such men as Elihu Thomson, Silvanus P. Thompson, Swinburne, Sayers, Menges and others. The plan was tried many times, but due to the fact that improvements in design made heating of the armature the limiting condition instead of sparking at the commutator, the auxiliary pole became unnecessary.

Recently the demand for a simple variable-speed motor offered an opportunity for the application of this old idea. The ideal method of varying the speed of a shunt motor is to change the field strength; but, under ordinary conditions, a limited range only can be obtained because the field becomes too weak to commutate. Here was the opportunity for using the auxiliary pole, and it was done; and this application for the specific purpose of obtaining a satisfactory variable-speed motor is a true and useful invention.

But the utility of this type of design, as shown by this application, has not stopped here, for other new conditions have arisen, such, for example, as the higher speeds of turbine-driven generators and the reduction of armature losses through improvements in design and in material, which may again bring the limiting condition back to the commutator; and these new conditions may be met by the further use of the auxiliary pole. Indeed, this has already been done. Inventions sometimes seem to go in cycles, but when we examine carefully each new appearance of the old idea, it is generally found to be for some new purpose or to meet some new condition; therefore this new application is a true invention.

The Twenty-ninth Convention of the National Electric Light Association.

Atlantic City, N. J., June 5 to 8.

A RECORD attendance inaugurated the opening session of the twenty-ninth convention of the National Electric Light Association, which was called to order on Young's Pier, Atlantic City, N. J., by President W. H. Blood, Jr., Tuesday morning, June 5, at 10.15 o'clock. Mr. Blood introduced the Hon. F. P. Story, mayor of Atlantic City, who extended the right hand of fellowship and a hearty greeting.

Arthur Williams, New York, N. Y., moved a vote of thanks to the mayor for his courtesy in addressing the convention and also moved a vote of thanks to the common council for the electrical illumination of the boardwalk. These motions were unanimously carried.

The president then presented his annual address, saying in part:

PRESIDENT'S ADDRESS.

"Last year we enjoyed the hospitality of the West, and the trip to Denver and Colorado Springs in special through trains was a feature of the gathering. This year you have come to the extreme East, where you may admire the Atlantic ocean with its tempestuous waves and contrast its vastness with the royal splendor of the mountains you saw last year.

"The association is to be congratulated upon its continued growth and prosperity. Two years ago, when we met in Boston, the total membership was 588. To-day we have nearly double this number, for we have enrolled 1,024. The vigorous campaign for new members, inaugurated two years ago, has been continued in a less expensive manner, but with most satisfactory results, by our efficient assistant secretary and treasurer.

"The question of annual dues should receive the prompt consideration of the incoming administration. It may be expedient to increase the fees of the companies operating in the largest cities. It is desirable, your president believes, to so adjust the dues in cities of ten thousand population, or under, that companies operating therein can not afford to stay out of the organization. We need the cooperation of just such members, and the affiliation with the stronger companies, through the association, will enable them to get information or assistance which, if operating alone, might be expensive, if not impossible to obtain.

"The class 'C' members—college professors—have received the careful consideration of your president during the past year, and as a result of his investigations he unhesitatingly recommends that they be treated as an honorary class, that no fees be exacted, and that they be admitted upon invitation only, and that each case be passed upon annually by the executive committee. We desire the fellowship of many earnest educators for their own sake and because of the influence which they have over the hundreds of young men they are sending out each year from the technical schools. On the other hand, this association has no place for the instructor, with only academic ideas as to corporate management, who in his capacity as consulting engineer either ignorantly or wilfully misrepresents the facts.

"Our relations with the underwriters have, during the past year, been pleasant, partly because there has been no question at issue between us and also because we are becoming better acquainted with each other. The policy of having a representative of the association devote the larger portion of his time to insurance interests and to settling differences between the members of the association and the underwriters has been approved by the executive committee, and is now referred to the incoming board for early action.

"The year has shown a healthy growth of the electric lighting business, but it is not notable as having given birth to any marked innovation in the physical part of the business. The size of generating units continues to increase, distribution by high-tension alternating current is becoming more and more general, and minor improvements all along the line are extending the utility of this system. Undeveloped water powers, which a few years ago were valueless, are to-day being eagerly sought out, and by means of improved water-wheels and high-tension lines are being made available for large sections of the country. Gas engines, steam turbines and other prime movers are receiving the careful attention of enterprising engineers, because we are all beginning to realize, more and more forcibly each year, that the great losses between the coal pile and the dynamo must be cut down.

"There has been a marked increase in centralizing the ownership of electrical undertakings. This has benefited the communities served, by bringing to their service better managerial as well as improved operating methods. This centralization is causing electrical managers to look more closely to their markets, and to-day the company that has not a new business-getting department is sadly behind the times.

"Allied with the question of rates is the problem of government supervision or regulation. This matter is demanding serious consideration at the present time. Witness the Massachusetts Gas and Electric Light Commission, which has been in existence several years, the newly formed New York State Lighting Commission and the bill just passed by the Massachusetts legislature adopting the English automatic method of control called 'The Sliding Scale System.'

"A study of the municipal undertakings in Great Britain and the constantly growing list of municipal failures in the United States shows that municipal ownership is, in fact, no longer as popular as it once was. Some agitation, however, is being kept alive by the socialist, by the unscrupulous political agitator and by the 'yellow journal,' whose whole fabric is based upon class hatred, whose teachings are that all riches come through stealing from the poor and whose very existence depends upon its ability to pervert the facts and to 'fake' reports so as to make interesting reading for the part of the public loving sensation.

"A general reduction in price for current and a readjustment of rates are constantly taking place all over the country. Flat rates are fast becoming things of the past, and wattmeters, in conjunction with various kinds of demand systems, are now almost universally used. Although the public has been for years trying to understand the demand system of charging, it still objects to it, and there is a feeling in some quarters that we may have to return to the straight meter rate, which, although admittedly unjust and unfair, still has a decided advantage in its simplicity."

The secretary announced that the following named associations had accepted invitations to send representatives to the meeting: Ohio Electric Light Association, Northwestern Electrical Association, American Street Railway Association, Association of Edison Illuminating Companies, Underwriters National Electrical Association, Kansas Gas, Water and Electrical Association, Canadian Electrical Association, New York Board of Fire Under-

writers, Underwriters Laboratories, National Board of Fire Underwriters, and the Southwestern Electric and Gas Association.

The secretary stated that he had also received letters of regret at their inability to be present at the meeting from past-presidents Edgar, Weeks and Doherty.

An invitation to attend the meeting of the Illuminating Engineering Society on June 8 was read.

The first business taken up was the report of the committee on progress, which was presented by T. Commerford Martin.

The year 1905 would appear to mark the beginning of a new period in the development of electric light and power in the United States. It would be difficult to define the nature of the change briefly. Perhaps it is safe to sum it up in the statement that the central stations of the country, realizing the cumulative effect of the reductions in the cost of producing and supplying electricity to the public, had united upon a commercial propaganda to sell the cheaper current thus rendered available. The central station manager has within the last two years received more advice as to the sale of his current than he endured as to its manufacture in the whole previous twenty. It may be asserted without the slightest fear of contradiction that the industry has been revivified by the "publicity" campaign of recent date, that it has ceased to minister to the comfort of the many in order to meet the necessities of the million, and that it has made splendid advances toward the accomplishment of its universal purpose and potentialities.

It was estimated in this report last year that there were 4,200 central station enterprises. The current issue of the authoritative *Central Station List* for the first quarter of 1906 contains the names of 4,839 plants, of which 3,732 were under private and corporate management and 1,107 were municipal. The gain in six months had been 301 plants, or 600 for the year, a very close proof of the maintenance of a steady and high rate of increase. While of these new plants in the first half of 1905-6 no fewer than forty-eight were in Texas, the older states were notably leaders in activity, Pennsylvania accounting for twenty-one and New York for eighteen, Ohio and Michigan for fifteen each.

An increase of fifteen per cent over 1904 would bring the investment in distinctive central station plants up to $700,000,000 in 1905. The gross earnings are estimated at $135,000,000, expenses on which at seventy per cent would amount to $94,500,000. As a matter of fact, the output of current was everywhere much larger than ever before, but the rates obtained were frequently much lower than ever before.

The production of apparatus and supplies for central station circuits and isolated plants may be inferred or estimated from the figures of 1904 just now made public by the United States Census Bureau. The total output of all strictly electrical apparatus for that year was valued, at the factories making it, at $157,949,514.

Turning to the figures for England for the year 1905, these show 262 distinct electrical supply plants, without trolley load, although this is far from doing justice to the lighting end of the art, as there are also no fewer than 122 stations with both lighting and tramway load. It would appear from "Garcke's Manual," an excellent guide to British electrical investment, that the companies devoting themselves to electric light and power employ $160,000,000 of capital, and that the returns reported by 187 companies show an average of 5.11 per cent. In addition there were 277 municipal plants employing $177,000,000 of capital.

Germany is the next, and, indeed, only other European country presenting authentic statistics of value in this country, and the figures available date to April 1, 1905, when there were 1,175 plants in operation and 540 in process of construction, if the reports be true, although that seems an almost incredible proportion between old and new enterprises for a single year. Since that time one-third of the projected plants are said to have gone into operation, making the present number about 1,500.

The year has witnessed a general reduction in prices for current and service all over the country, and an extension of metered service, limiting still further the use of the "flat rate," unmetered system. But there is to-day no greater agreement on methods of charging than before; and the present meeting will doubtless do its share in bringing out the merits of and arguments for, the various "maximum-demand," "two-rate," "readiness-to-serve" and other tariffs or rate principles. Meantime a great many companies have addressed themselves to the problem of building up the load at certain times and seasons.

W. S. Barstow, Portland, Ore., read a paper on "Mercury Arc Rectifiers System, with Magnetite Lamps for Street Illumination."

There has during the last two years been in course of development a new system for outdoor street arc lighting, which not only promises to take an important place in the history of the art, but in many instances to replace the carbon arc. It is actually the first successful effort to increase commercially the efficiency of outdoor arc illumination, while at the same time it opens up new fields where the present type lamps can not be used. The magnetite mercury arc rectifier system requires not only thirty-five per cent less energy at the lamp than any existing system for the same illumination, but makes it possible to do outdoor street arc lighting from transmission systems of thirty-five cycles and under without the use of motor-generator sets or other moving apparatus. In the city of Portland, Ore., about two years ago this system was installed on a small experimental scale. About one year ago the results appeared so promising and so much progress had been made in such a short period that an order was placed to install the entire system of over 1,200 lamps in Portland with mercury arc rectifiers and magnetite lamps. There have now been in operation in Portland for several months over 800 lamps with rectifiers, and the installation is being rapidly increased as fast as deliveries can be made. The system has proved successful and has fulfilled expectations. Considerable difficulty in the form of static discharges and short life was at first experienced with the tubes. The tubes, which were of small size, were subjected to very rigid requirements on account of the alternating-current pressure of 18,000 volts, a pressure which was very much higher than anything yet attempted with mercury arc rectifiers. The tubes have now averaged over 650 hours and several have exceeded 730 hours, 500 hours being the economical requirement, and anything above this being in the nature of a gain in the original calculated efficiency of the system.

If in a modern installation where low-frequency alternating-current is transformed by synchronous motor arc machines into direct-current energy for present type of 500-watt arc lamps, there should be installed the constant-current transformer mercury arc rectifier system with magnetite lamps, the gain in efficiency for the same illumination would amount to 294 watts per lamp or 1,176 kilowatt-hours per lamp per year.

The high commercial efficiency of the

latter system is due to a very large extent to the simplicity and economy of the rectifier tube itself. A tube of a capacity of about thirty kilowatts has a constant loss of but twenty-five volts or, at four amperes, 100 watts per hour, while the cost of renewing the tube on the basis of 500 hours' life about equals the cost of labor and renewals on a motor-generator set.

In the use of the magnetite system a commercial question arises which, after very careful consideration, should be definitely answered before the system is adopted to any great extent. I refer to the specifications used in the present public lighting contracts. About fifteen years ago considerable thought was given to the subject by this association, resulting in a campaign of public education which produced the proper result at that time of rating street arc lamps by the "watts in the arc" and dropping out of contracts the terms "normal candle-power." If the price of public lighting is to be fixed by "watts in the arc" on the same basis as present cost, the public will profit by this lamp (due to lamp efficiency) to the extent of thirty-six per cent, the company gaining in transformer efficiency to an extent of seventeen per cent.

The question as to how the public and the companies should share this gain so as to determine under what specifications the illumination should be furnished is a broad one and is a matter that should be carefully considered at this time, so that the introduction of this new system shall be accompanied by a proper standard form of specifications.

J. H. Hallberg, New York, asked what the exact cost of these tubes was, say, for a 150-light outfit, or, say, two seventy-five-light tubes.

Mr. Barstow replied that the minimum cost of the tube is $15, that is for a seventy-five-light set, and the cost of the tube about balances the labor of attendance and renewals on a motor-generator set. The labor cost is very small on the mercury arc rectifier system, one attendant easily taking care of a 1,200-light installation and also all the other apparatus in the station.

Mr. Hallberg asked how the investment with this system compares with other standard forms of arc lighting systems, and if, taking into consideration the saving of something like thirty per cent in the original capacity of the plants, one would come out even at the additional investment which may be necessary for this new system, which is still not in extensive use.

Mr. Barstow said that the cost of the transformer mercury arc rectifier, switchboard panels and reactances, which is really the transforming apparatus, is just about the same as a motor-generator set; so that no benefit has been given to the system of any interest on the saving on the original investment of the generated energy, it being simply considered as a transforming piece of apparatus.

Mr. P. D. Wagoner, Schenectady, wished to correct one impression which Mr. Barstow's remark in regard to the cost of the tube might give. The figure which Mr. Barstow mentioned was a figure which was arrived at when the industry was very young and when there was very little data obtainable as to the exact cost of manufacture. More accurate data on this point would be to say that the tube cost is $25, with a $5 rebate for the return of the old tube, the salvage value in the old tube. He thought the important consideration, however, was the maintenance per circuit per year, from the tube standpoint. The figure considered ordinarily in discussing tube life is 400 hours, which on an average circuit would be ten tubes per year, at a net price of $20, $200 per circuit per year, which even on a fifty-light circuit would be only $4 per lamp per year.

In connection with the illumination with the magnetite lamp Mr. Wagoner said that, due to the fact that the light comes from the arc itself, the distribution of illumination for street lighting is very much better than a lamp in which the light comes from the crater which may give the same total spherical candle-power.

Arthur Williams, New York, said that, in view of the fact that several new types of illumination for street lighting have been brought to our attention and are available for that purpose, it seemed to him that this might be a very good time to take up this question of municipal specification for municipal lighting.

Mr. Williams raised a question as to the performance of these lamps, how they act upon the circuit and whether they are more sensitive to line disturbances, whether there is any increase in outages as compared with the standard type of enclosed lamps, and whether in a sense of maintenance and inspection the cost varies greatly from the present standard systems.

Mr. Barstow stated that at the beginning of the installation of the magnetite lamp, considerable trouble developed with just the point mentioned—the outages were frequent and the performance of the lamp was very bad indeed. Upon very close investigation and testing of a large number of lamps it was discovered that the mechanical part of the lamp was very satisfactory and that the main trouble in the system was in the magnetite sticks themselves. The magnetite sticks are composed of a little sheath of iron filled with the magnetite ore. This was packed into the sticks by hand. It was found that the outages in the lamps were due to a little button of slag formed on top of the magnetite stick, and this forming of slag, which insulated the contact and produced the outage, was due to the uneven packing of the magnetite stick; in other words, in packing the stick by hand a certain amount of the mixture was measured out to each one and the workman was required to pack all of it into a certain space in the tube. In starting in to pack the stick, if the workman found it was running a little short he would pack the balance somewhat loosely; on the other hand, if he found he had some left over he would pack the balance very tightly, and this produced an uneven character of stick, which produced the slag, which produced the outage. As soon as the manufacture in quantities was begun and automatic packing machines were used it was found that this defect disappeared. The only trouble now experienced occasionally with the lamp is due to defective manufacture of the sticks themselves, but these sticks are being manufactured in larger and larger quantities and are becoming better and better, so that the outage at the present time, and the inspection required, are less than they were with the old system. The lamps have been very satisfactory since the new lamp was put in, and in the last year there has been little trouble experienced, the principal difficulty being in the starting up of the lamp owing to the fact that the metallic electrode requires considerable time to heat up to form the arc as against the carbon electrode. This has been overcome by arranging for the transformer to give an increased voltage at the start, which runs the current up to 4.5 amperes just at the instant of starting, which heats the stick up quickly and the lamp settles down at the end of a few seconds and burns continuously.

Louis B. Marks read a paper on the "Flaming Carbon Arc."

The paper discusses at length the characteristic differences between the flaming carbon arc, the ordinary open and the en-

closed arc. The conclusions reached are:

First—That the flaming carbon arc lamp of commerce produces five times the total luminous flux of the enclosed arc lamp for the same expenditure of electrical power in the arc.

Second—The lamp is well adapted for purposes of illumination where a flood of light is desirable in a single unit, as, for instance, for advertising purposes.

Third—The lamp may be used economically in the lighting of some large interiors, and in large open spaces, such as public squares and wide boulevards, if the lamps are placed at a considerable height, say forty to fifty feet above the ground.

Fourth—The concentration of such a large flux of light in a single unit renders the lamp unsuitable for purposes of ordinary street illumination in the United States.

Fifth—The advantage of economical production of light is offset by reason of the necessity for frequent trimming with expensive carbons.

Sixth—The fumes and ash given out by the lamp, the unsteadiness of the light, and the objection to frequent trimming, render it unsuitable for most cases of interior illumination.

Samuel Scovil, Cleveland, asked what was the probability of the cost of the carbons being materially reduced.

Samuel Scovil moved that the secretary appoint a committee to consider the president's address, to make such recommendations in regard thereto as they may deem advisable. This motion was carried.

Secretary Eglin announced as the committee to consider the president's address the following: Samuel Scovil, Arthur Williams and T. C. Martin.

It was moved that the president appoint a committee to consider specifications for street lighting, to suggest some modifications of the requirements that are embodied in specifications for street lighting as they now exist, and to report as soon as possible. This motion was carried and the meeting adjourned until two o'clock.

TUESDAY AFTERNOON, JUNE 5.

President Blood called the meeting to order at 2.20 o'clock and announced the first business to be the report of the committee on steam turbines, W. C. L. Eglin, chairman, and I. E. Moultrop.

The turbine situation has very materially changed since the committee's first report. To-day the steam turbine is recognized as a standard piece of apparatus, and turbines of some type are being installed in nearly all of the newer powerhouses.

During the discussion at the meetings of the committee it was decided that it was unnecessary to continue any further tests on economy, as there were now so many turbines installed in regular operation giving satisfactory results; and the most important matters receiving attention were the various details which go to make up reliability and insure continuity of service.

The committee decided to visit the works of the manufacturers again this year, as it was thought the greatest benefit could be obtained for the association by a full and free discussion with the engineers of the manufacturing companies covering all of the information in the hands of the committee concerning the turbines built by the several manufacturers. This had been done, and the report dealt with certain new details in design.

The steam turbine committee was given a vote of thanks for its continuous service, for the reports which it had presented during the past three years, and the committee was discharged.

A paper entitled "Mechanical Refrigeration" was read by John Meyer.

At the present time central station interests are scanning the field for sources of revenue other than that derived from the sale of current for arc and incandescent lighting.

Mechanical refrigeration, having as its source of power the electric motor, is an outlet for our produce and deserves much consideration. The paper deals with this subject, practically new from a central station point of view.

The machines now used to produce a reduction in temperature are nearly all based on the principle of production of cold by the evaporation of liquids to the gaseous form. Preference is given to either ammonia, sulphurous acid or carbonic acid, as the evaporating liquid.

About two years ago the Philadelphia Electric Company detailed an engineer to solicit this class of business. With the able assistance of the advertising bureau many enquiries were received and contracts closed, the consumer introducing the equipment at his own expense. We succeeded in securing installations in different lines of business.

The various applications mentioned in this paper are entirely manual control. An automatic system has been developed, but unfortunately no plant of this type is in operation in Philadelphia, and we are therefore unable to present any data.

The capacity, horse-power of motor, average box temperatures and average hours of operation, as noted in the table, are the results of actual tests of plants in Philadelphia.

Generally speaking, two horse-power must be installed for each ton of refrigerating capacity.

The refrigeration question introduces problems distinctly technical, and it is hardly possible to work up a large load through the regular soliciting force, except possibly to interest the prospective consumer, after which the question should be referred to a competent engineer.

Business.	Capacity.	Horse-Power of Motor.	Average Temperature of Box.	Average Hours to Operate.
Dairy	3 tons	7.5	38	8.0
Grocery	200 lbs.	0.5	34	7.6
Drug	3 tons	Com. 7.5 Pump 1.0	33	Com. 4.75 Pump 15.0
Butcher	3 "	7.5	36	6.0
Residence	500 lbs.	2.0	39	8.5
Saloon	500 "	2.0	40 min. 45 max.	9.0
Restaurant	500 "	2.0	35 min. 45 max.	15.0

W. W. Freeman, Brooklyn, N. Y., stated that a practical difficulty has been experienced in reference to refrigerating apparatus in his territory and he asked whether it is peculiar to his town, or whether it has been at all general. It seemed some months ago that there should be considerable business obtained in electrical refrigeration, and following the plan of Philadelphia, a department was organized to exploit this feature of the business. Within a comparatively short time twenty-five or thirty places where refrigerating apparatus could be installed were found, but apparatus was not available. The refrigeration department was abandoned for the reason that after orders were secured the refrigerator plant could not be obtained.

Fred E. Matthews, Hartford, Ct., said that in the last year abnormal conditions prevailed which no manufacturer, no matter how large his plant, had been able to meet. The largest manufacturers of re-

frigerating machines in the country have been unable to make deliveries short of ninety days, and some have been in even worse condition. This condition, however, has not been experienced before at any time in the history of refrigeration. As to the question as to how this can be remedied, it will look after itself in the future. The manufacturers will undoubtedly adopt measures to protect themselves against these abnormal conditions.

S. B. Storer, Buffalo, N. Y., asked Mr. Meyer if he had made any attempt especially to make use of the ice machines to supply a low spot in the load curve; in other words, to build up the all-day load of a plant.

Mr. Meyer said he treated the refrigerating problem the same as a general power proposition. It is a mistaken idea that the refrigerating business does not cost as much as the general power business.

A paper entitled "Fuel Economy," by J. Henry Hallberg, was then read.

In recent years it has been realized more and more that the methods employed by the average fireman are anything but ideal, and that a great waste of fuel could be avoided if the results of stoking could be improved.

In time great efforts were made, and among the various improvements invented, a prominent position must be allotted to mechanical stokers. There is no doubt that these appliances on the whole handle coal more economically than the average fireman, but they also require attention; and, as they do not eliminate the personal element entirely, even they are in themselves no safe guarantee of good results.

It is to-day universally acknowledged by engineers that the most reliable, most minute control of the results of combustion is obtained by means of continuous analysis of the flue gases and by determining the percentage of CO_2 (carbon-dioxide) they contain.

It is in the power of every engineer to improve considerably the working results of the particular installation under his care, and to raise it to the highest standard of economy within the possibilities of the particular plant, by means of keeping continuous records of the percentage of CO_2 obtained in the furnaces.

A few days of experiment will determine the exact draft pressure necessary for the highest attainable combustion, and the dampers will be regulated accordingly.

It will be easy to ascertain what method of firing will bring the best results, and what thickness of fire should be maintained. Should there be any flaws or cracks in the brickwork, or "holes in the fire" these will be easily detected and at once remedied. Not infrequently, changes in the design or size of the grate, or improvement in the flues or the chimney suggest themselves, which when carried out are the means of further improvement in the combustion and economy of fuel.

Several years ago Mr. Arndt, of Germany, invented and patented an automatic CO_2 recorder. A large number of these recorders have been in practical service abroad during the past four or five years, and in most cases the fuel saving has paid for the recorder in six months' time; in a few boiler plants the recorder paid for itself in a single month. Some months ago this recorder was imported to this country and one was installed in the largest electric power plant in New York city. The operation of the recorder was so satisfactory that three additional instruments have been ordered. Some large users of boilers in this country have placed their orders within the past few months, and several recorders are now installed and are giving excellent service.

Luther R. Nash, Savannah, Ga., thought there was no doubt as to the great advantage to be obtained by an analysis of flue gases, but he thought Mr. Hallberg was perhaps a little mistaken when he stated that a continuous record is the only thing which is of any use. The exact advantage to be obtained by a continuous record as compared with an intermittent record is only assumed. A continuous record is of advantage in some cases, but many small plants would hesitate to spend $400 on an apparatus for this record. There have been hand-operated devices on the market for many years for analyzing flue gases. The results obtained by the apparatus for ascertaining the percentage of CO_2 alone, which an engineer can use and attach to his furnace or the stack, if he desires, to determine the percentage of gases or the disposition of the load, are very satisfactory. In his own case, after looking into the question of analyzing flue gases, carefully, he had decided that he would experiment with the hand-operated device to see what results can be obtained in that way, and determine whether the possible additional economy by having a continuous record would justify that extra expense. By taking an occasional record he thought the adjustment of drafts and dampers could be worked out, so that a large part of the saving obtained by continuous records could be arrived at.

Mr. Hallberg replied that hand-operated instruments of any sort in a power plant should be avoided as a general proposition. There is great reason why the manager or superintendent should know what takes place in the furnace, where the losses are greater than in any other part of the plant. That is the vital spot in the central station system that he can well afford to know, always and at all times—what is going on in the furnace and how the firemen are behaving when he is not around. A hand-operated machine will not give a continuous record, and the conditions may be exceptionally favorable at the time the record is taken. He believes that if any records at all are to be had they should be automatic, continuous records, which show instantly, by glancing at them, whenever the furnace door was opened or a damper changed in the wrong or right direction.

The paper on "Electric Heating," by James I. Ayer, Boston, Mass., was then read.

Mr. Ayer presented a brief paper directing attention to the great possibilities of installing electrical heating devices among residence customers. He showed a table of costs for hot-water heating which makes this an attractive proposition. The policy to pursue, he says, is to press the sale of these goods constantly until their own popularity will cause them to come in great demand.

President Blood called upon Max Loewenthal, New York, to open the discussion on the paper.

Mr. Loewenthal thought that central station men were taking a greater interest in the evident wants of customers, and that is bound to work for their benefit. Regardless of that fact, however, the development of electric heating has been small and is still very much limited. When it is considered that only forty-four per cent of the population of 5,000 cities in the United States have access to the electric current, and then think for a moment how small a percentage of this forty-four per cent actually use it, it will be admitted that the use of current is extremely limited. There are two reasons for this—one is that the public is not educated up to the point, the other is that they are prejudiced against all things electrical.

The paper on "Line Construction for Overhead Light and Power Service," by Paul Spencer, was read by W. D. Partridge, who assisted Mr. Spencer in the preparation of the paper.

The points to be considered in line

construction in the order of their importance are the following:

First and foremost, to which all others must be entirely secondary—the safety of the public and the company's employés.

Second—The reliability of the company's service.

Third—Sightliness of the construction.

These first two requirements, safety and reliability, can be considered together, the first embracing the second, for safe construction implies reliability of service.

To meet these requirements we should use, first of all, structurally sound material, of ample strength to withstand, under all conditions of service, the strains to which the line may be subjected.

The poles should not have less than seven-inch tops, should be set not less than five feet in the ground and be held firmly by substantial guying against side or end pulls.

The cross-arms should be of sound, honest wood, and not the sap-wood variety, which are covered with so-called red paint to hide their defects, and which are made up of the leavings of the mills after the good wood has been cut into building timber and flooring. They should be firmly bolted to the pole and should be braced.

The line wires should not be less than No. 6 B. & S. gauge in size, and they should be strung with ample clearance over highways and footways and should be inaccessible to the general public from bridges or buildings.

The guy wires should be of stranded cable and not solid wire. They should be insulated and, so far as possible, installed so they can not be easily reached from the ground.

Ground wires should not be installed unless they can be connected to a permanent and effectual ground. A ground wire connected to a poor ground not only fails when it becomes charged to give the protection for which it is supposed to be installed, but becomes a positive source of danger to the passer-by.

For the safety of employés, pole wiring should be carried out in a systematic manner, so as to leave space on the pole for climbing and working thereon.

To protect the trimmer, series arc lamps should have absolute cutouts.

The author concludes his paper with lengthy quotations from the line specification recently prepared for the electric companies of the United Gas Improvement Company and of the Public Service Corporation of New Jersey.

C. T. Mordock, Terre Haute, Ind., asked Mr. Partridge if in his construction work he has ever used for making joints the McIntyre sleeve used by telephone companies, and, if so, how he found it in electric light construction.

Mr. Partridge thought that for the most part all line work is made without the McIntyre sleeve joint, but he was quite positive that a transmission line carrying 13,000-volt, No. 00 copper wire, three miles long, was joined with McIntyre sleeves, and apparently with satisfaction, having been maintained for approximately two years.

S. J. Rhodes, New York city, asked Mr. Partridge if he thought the best results would be obtained by putting all lines on one pole, rather than putting the electric light company lines on their own poles, and segregating the telephone and fire-alarm telegraph systems.

Mr. Partridge said that with a street to which three or four kinds of service was to be sent it is impossible to maintain independent rights of way. It is certainly desirable if it could be done, and if one company can take one side of the street and the other company take the other side of the street, from the standpoint of the companies, that is the desirable thing. From the standpoint of the public one set of poles is enough, and he thought the companies ought to meet that proposition heartily from the standpoint of the public and attempt to set as few poles as possible on the streets.

The discussion on Mr. Marks' paper, "The Flaming Arc," was resumed, Louis J. Auerbacher opening the discussion.

The meeting then adjourned until Wednesday morning.

WEDNESDAY MORNING SESSION—JUNE 6.

The first paper of the Wednesday morning session was entitled "Business-Getting Methods," by Frank W. Frueauff. This paper is presented in abstract elsewhere in this issue. In the absence of the author the paper was read by John Craig Hammond, of New York.

Following the reading of this paper D. F. McGee read a paper entitled "How to Make a Small Electric Plant Pay."

The boiler room is usually the most neglected part of a small plant equipment. Uncovered pipes, leaky valves and joints, improper boiler setting, careless firing and injudicious selection of fuel, are a few of the dividend-consuming devices common to small plants.

Boilers should be inspected at regular intervals and kept free from scale. Every steam plant should have recording thermometers installed in the feed-water lines to boilers.

Recording voltmeters will provide a healthy incentive for your men to attend to their duties. It is well known that one of the chief difficulties in small plants is to have competent help available when accidents or other trouble occurs, which is generally during the time of the heaviest loads.

He has provided for this by dividing the power-house force into three watches, with the understanding that they are to work ten hours per day. This provides double force on duty two hours each day to make all repairs and tide over the peak-load period.

Engines should be indicated regularly, and valves adjusted for the most economical steam consumption. Tests of water and fuel consumption should be made at stated periods. The distributing system of a small plant is very often the source of considerable waste.

The manager of a small plant must keep posted regarding the latest and most efficient types of different apparatus, lamps, reflectors, and so forth. He should read all the trade publications; not only the reading matter, but should study the advertisements as well. He will miss a great deal of valuable information if he does not. He will often find the solution in those pages of some difficult problem that has bothered him for months.

With all due respect to advertising, it must not be thought, however, that the getting of new business, in a small city, is dependent on advertising alone. There must be good and reliable service as a foundation for all this. The service must be continuous and free from interruption. Voltage must be steady. With such good voltage regulators on the market, there is no excuse for poor regulation. Customers' installations must be looked after by the central station manager to insure their being maintained in good condition. He must watch the little things, keep dim or other inefficient lamps weeded out. At an early date he adopted a liberal policy regarding free lamp renewals.

It is essential to have a schedule of rates that will attract the long-hour or all-day customers for both light and power.

You must educate the people away from the idea that electric light is for the well-to-do only, for the difference in the yearly cost for redecorating houses where electricity, gas or kerosene is used will often more than pay the entire electric light bill for the year.

The next paper was a symposium en-

titled "Some Methods Used in Securing and Retaining Business," presented by Mathias E. Turner, Norman I. Wilcox, Geo. N. Tidd, R. S. Wallace, Geo. B. Tripp and Leon H. Scherck. Mr. Turner said in part:

Early information pertaining to the erection of new buildings is obtained through the various information agencies. Solicitors are then set to work. The ability of a solicitor to offer the free services of an expert many times decides the architect, engineer or tenant of a new building to use electricity, and often to use it to the exclusion of any other forms of light or power.

Increasing the use of electricity where it and competitive illuminants are used in stores, is successfully accomplished through the efforts of illuminating engineers working in conjunction with solicitors. A lighting expert analyzes the illuminating value of the existing installation, advises the canvasser as to the arrangement and kinds of electric lamps to use to give the most effective light at minimum expense, and estimates the cost of doing the necessary work. The solicitor then has little trouble to induce the proprietor of a store to try the new scheme of lighting.

Another method, which is used chiefly among the residences, is suggesting through the medium of a monthly bulletin different conveniences made possible by the fact of electricity being in the premises.

To retain business previously obtained demands careful watch of customers' accounts, to offer them any general reduction in prices that may be offered to prospective customers, and further requires continual investigation of their electrical installation. It becomes imperative upon the part of the company to keep its agents circulating among its customers, particularly the stores, suggesting means of adding to the efficiency and attractiveness of the electric light with the view of rendering the best possible service for the least amount of money.

Norman T. Wilcox. The fact that so many rate sheets have recently been or are being revised shows that the more progressive plants are realizing the importance of reasonable rates. Given the devices that we know to be good, we must in some way obtain the interest of the prospective customer and create a desire for our product. We have recently taken men of good address, who are ambitious and willing, from our operating force, given them a definite district in which to work, equipped them with portable motor cords, high-efficiency or other lamps, and necessary apparatus for making a demonstration on the prospective customer's own premises. If there is no supply wire on the premises, we run a temporary service. With motor customers, we place a motor and run it a few days free of charge, so that that customer can see how much better we can do his work.

These methods are proving most satisfactory and enabling us to get business months and years before we could if we relied on talk alone for an argument.

Geo. N. Tidd. A list of the business houses, factories and residences is made and kept carefully up-to-date. At least once a month a mimeographed personal letter is sent to every name on this list, setting forth one or two advantages of electric current for heating, signs or power, depending upon the character of the business. A number of these letters are prepared in advance, so each name will receive a consecutive line of argument or suggestion. If the letters after a few months have met with no response they are followed up by a personal call.

An attractive show window and display room is of great importance.

A large portion of the field from which the new business is recruited is the long-hour business, both light and power. It is necessary to have a variety of forms of contract which will allow the development of this character of business.

The retaining of the old business is of even more importance than the securing of new. When complaints come in they are immediately thoroughly investigated.

One of the points neglected by the average central station management is the awaiting of complaints. Have your solicitors call upon your consumers. Take an interest in their lighting and power, and see that they are securing the best results obtainable before they complain.

R. S. Wallace. Personal solicitation is the most effective means of securing new business. Do not end your work with training your solicitor. Work up the interest of every man connected with the company. The salesroom is a most important adjunct of the new-business department. Make your selling prices for appliances bring you the same rate of profit a dealer would expect, but scrupulously put into advertising or soliciting every cent of such profit. This practice will encourage dealers to handle electrical appliances. An index of all the buildings in the territory is essential. Make use of every legitimate means of securing desirable publicity for your company. Use a portion of your new-business appropriation for purchasing advertising space in programmes for church entertainments and so forth. Newspaper advertising, properly used, is an effective new-business builder. A campaign of direct advertising by mail will still further increase the solicitor's efficiency. Keep in touch with your contractors; establish friendly relations with them and consider their criticisms and suggestions.

Geo. B. Tripp. A new-business department should be instituted with a manager in charge. Then the territory of the city should be divided into districts, so that one man would look after and solicit from consumers in a territory of from six to eight thousand population.

"Follow-up" letters is a method which can be used to great advantage, coupled with the work of good solicitors. He is a great believer in advertising, if used judiciously, but place solicitation first and above all other methods for obtaining new business.

In order to retain profitable business the rates for service must be as low as possible, commensurate with the costs and securing a fair return on the investment. The service must be maintained at the highest standard, which means that the station regulation must be kept up as efficiently as the best engineering practice will allow, that the various current devices used by the consumer must be inspected by the company's representatives as often as necessary not only to secure a maximum income from the use of same, but, in addition, to see that said devices are operating efficiently. Give the consumer the attention that he is accustomed to receive from his mercantile house or the salesman from whom he buys goods, and not assume that he must come to you for the commodity that you sell.

Public-service corporations should deal with the general public, and with the municipality that each serves, from the point of view that the electric company has nothing to conceal, and is ready at all times to answer sensible criticisms. Municipal ownership agitation has in the past gained strength because of the secrecy that has shrouded the reports of operating companies, which has resulted in the general public suspecting that companies were earning enormous dividends.

Leon H. Scherck. We should strive to secure only such business as we feel reasonably satisfied we can retain, and that after having once secured a customer we

should constantly study his needs and at all times endeavor to keep him satisfied. If we do this our "cutoffs" will be comparatively few.

A method which we have found effective is to have a canvass made by the solicitors (house-to-house) of every place within the vicinity of the company's lines or of probable extensions. These cards are sorted and then filed geographically in a suitable cabinet, and when the canvass is completed, the card catalogue furnishes a record of every house near the company's lines, whether they use electricity or not. If this system is properly followed up it furnishes at all times a complete record of the entire city and enables a manager to see at any time the amount of available business and how effective the soliciting department is.

Free Signs. We have succeeded in building up an immense sign business in several cities (in one situation nearly sixty cents per capita) by having the company furnish, erect and maintain signs at a flat price per month on contracts varying from one to three years.

Free wiring is something that should be handled judiciously. A plan we have tried is this: The company offers to wire six outlets in a place (consumer paying for the flexible cord and sockets and all fixtures), provided the customer guarantees a minimum monthly bill of $1.00 for a period of one year; any extra outlets to be paid for by the customer. The number of premises secured in the above manner bring in a surprisingly large amount of business. In one situation fans rented at $1.00 a month have brought in a large fan business.

Opening the discussion on these six papers Frank W. Smith, New York, gave some details of a circular-letter campaign which the United Electric Light and Power Company had conducted in securing profitable business from large department houses for lighting and elevator service. Two letters were sent to each prospect. Nine per cent of these letters resulted in enquiries, and of this nine per cent seventy-five per cent resulted in contracts. This brief campaign resulted in securing an equivalent of 6,600 candle-power.

M. S. Seelmary, Jr., then spoke upon the value of direct advertising and the utilization of a return postal card. The Edison Illuminating Company of Brooklyn had the opportunity of buying a consignment of fans. Direct advertising was sent to a selected list, each announcement being accompanied by a return postal card. In a few months 1,300 fans were sold with a consequent increase in consumption of current.

John F. Gilchrist, Chicago, Ill., thought that employing solicitors on a straight commission basis was a poor system. One solicitor might secure a church or theatre and get a big commission, while another, working a great deal harder, might get very little return. In Chicago certain districts are apportioned to each solicitor, and it is expected that certain business should be secured. His company has found that good pay, for good men, with a cash bonus laid upon the net earnings of business secured, proved very successful.

A motion was unanimously passed that the president appoint a committee to discuss means to improve the demand for new business, this committee to be called the "Committee on Exploitation," and will report at the next annual meeting.

WEDNESDAY AFTERNOON SESSION—JUNE 6.

The session was opened by the reading of the paper on "Profitable Commercial Cooperation," by J. Robert Crouse.

Mr. Crouse outlined a comprehensive plan for cooperation among every industry connected with electrical development, the essential characteristics of which are already well known. That this plan was feasible it was confident, as it had been solved from a study of conditions by the brightest minds in the electric field to-day.

Mr. John F. Gilchrist read the paper, "Report of Committee to Cooperate with Manufacturers' Advertising Committee," by Paul Spencer, John F. Gilchrist and J. E. Montague.

An interesting paper presented last June at the Denver convention had for its theme the possibilities of extending and increasing the use of electric current. This it was proposed to accomplish by concerted action on the part of manufacturers, dealers in electrical supplies, and all others interested in the increase of the electrical industry, in a scheme of systematic advertising for the purpose of educating the public in the applications of electric current and the advantages of its use. It was stated that definite action along these lines was about to be taken by some of the manufacturers to whom the idea had commended itself.

This association was asked to cooperate in the proposed work of the manufacturers' committee to the extent of appointing a committee to act in an advisory capacity.

The financial obligations of the work as at present formulated rest upon the manufacturers. The central-station interests have been asked to bear no part of the expense. As the work develops similar consideration of self-interest may lead the central stations to feel that it warrants financial support in proportion to the benefits derived. In the meantime your committee believes that the movement should receive the unqualified moral support of the members of the National Electric Light Association. The success of the scheme lies very largely in the hands of the central-station interests and the attitude which they assume toward it will undoubtedly be the determining factor in influencing the manufacturers' committee to carry out in full the work which has been planned.

In conclusion the committee recommends that a committee of the National Electric Light Association be again appointed in the coming year to assist the Cooperative Electrical Development Association in the work which it has planned to do.

It was moved that the committee be appointed to continue the work of cooperation with the manufacturers. Motion carried.

Converse D. Marsh spoke warmly in favor of supporting the Crouse plan and said that he thought that the comprehensive plan was entirely possible of carrying out.

Mr. Gilchrist thought that the association should pass resolutions in support of Mr. Crouse's work to get and hold the manufacturers in line to assist in the plan of cooperation.

The report of the "Committee on Protection from Lightning During 1905," in the absence of Alex Dow, chairman, was read by Robert S. Stewart, who, with Mr. Dow and C. A. Honnold, formed the committee.

The effects of lightning and static disturbances depend so much on local conditions and are felt at such rare intervals that it is not possible to formulate any general principles from the study of the experiences of a single lighting and power system. If, however, we tabulate the experiences of a large number of stations, located in all sections of the United States, these statistics should be very helpful in deciding on what methods of protection should be adopted in any particular case. In order to obtain such statistics the committee sent to each of the companies in the National Electric Light Association a

circular letter asking for information in regard to lightning troubles during 1905.

The replies were classed under two general heads: stations operating under 10,000 volts and stations having transmission lines of 10,000 volts or over. Each one of these two classes was divided into three, as follows:

A. Companies suffering no damage.

B. Companies whose losses were confined to lightning arresters and meters.

C. Companies suffering more serious losses. All who had lost transformers or other expensive apparatus were included under this head.

A table was given showing the results of the enquiry. In all 113 companies reported.

Two-thirds of the companies have been practically free from trouble. This proportion holds in the high tension as well as the low-tension plants.

The money value of property destroyed by lightning is extremely small compared with the value of the plants, for, even when transformers are burned out they can be repaired at a moderate expense. The principal loss is due to interruption of service.

The freedom from trouble is due largely to the increased use of lightning arresters and largely to the high grade of insulation in modern transformers and generators.

N. J. Neall opened the discussion on this report. He did not think that all the companies interested did not respond. The interruption to transmission was, possibly, more important than the damage to apparatus. The relative strength of the protective apparatus and the apparatus to be protected should be taken into consideration. Sometimes, in old construction, it is easier for the discharge to get through the transformer or other protected apparatus than through the protecting device. With regard to the discovery of a better resistance material, the manufacturers were to do the best they could with the material at hand. All resistance has some peculiar defect and the manufacturer has to effect a compromise to secure the best result. The suggestion of keeping a close record was admirable. But the taking of pin-point records should be taken a step further and tell-tale papers freely inserted so as to have a record as complete as possible.

The paper on "Grounding Secondary Alternating-Current Service," by Sidney Hosmer, in the absence of the author, was read by C. H. Herrick.

In the spring of 1905 the Edison Electric Illuminating Company of Boston, as a result of an increasing number of accidents and the removal of the bar previously maintained by the insurance interests, determined upon the policy of grounding all alternating-current services, at that time numbering about 5,500, scattered over fifteen towns. After some deliberation as to method, it was thought that the best and cheapest way to do this would be by connecting each service with the nearest water pipe in the building.

This arrangement made necessary the obtaining of permission from the householder—a rather laborious process—and, as the insurance interests thought best to require the wire run on the outside of buildings, it did not add to the appearance of the houses. Before undertaking it, therefore, the effort was made to ground in the street at the transformer. A large number of trials of this method over our entire territory demonstrated that it would be impossible to get satisfactory grounds at any reasonable expense. These trials were made by digging and by driving, going as far down as forty feet. It was then decided that all services where less than twenty were supplied from one transformer or main should be grounded individually on water pipes and larger groups should be left for further investigation and trial of street ground.

Having arrived at the conclusion that individual services should be grounded, various conferences were held with the insurance interests and with the municipal authorities having jurisdiction, and certain detail rules were formulated by some of them as to the treatment of the ground wire in buildings.

In general, these rules required the following:

1. All installations to be tested and if below insulation requirements of the underwriters' general rules they could not be grounded nor could any installation fed from same transformer or main. (This requirement was afterward modified to call for a minimum insulation of 10,000 ohms.)

2. Wire to be treated as an electric light wire, not less than No. 4, and to be run on outside of building as much as possible.

3. A special clamp for water pipe was prescribed.

Several contractors were then sent out with instructions to install twelve grounds under these rules and submit a flat price per ground for covering all our territory, and two were afterward awarded the contract. Next, the tenant or owner of each building in which a ground was required was visited and permission obtained for doing the work. A certain amount of difficulty was encountered in this stage of the work, but a comparatively small percentage of refusals was received. Where the customer did refuse, he was required to sign a release, accepting the responsibility himself. On new business coming on to the lines, the installation of the ground wire by the building owner is made one of the requirements for service, unless he is willing to sign a release.

The insulation test requirement has been the one thing that has caused the most trouble, as not only is there the labor of making the test, but one bad installation will, of course, prevent grounding all installations fed from the same source.

Practically all the services are grounded now except those held up by low insulation, and these are in the hands of the insurance underwriters to compel correction.

W. T. Morrison, of the New York Edison Company, made many tests to determine the effectiveness of grounding through ground plates, by a bundle of copper wire and by connecting to water main. He has found some very high resistances, and in other cases got a large flow of current. He has determined that in the district under consideration, involving some 4,000 kilowatts, it would be much cheaper to extend a neutral throughout the system and ground it solidly to a large salt water main. He had tried grounding a large copper plate, surrounded by coke, near the river bank, and was not satisfied with results. On the whole it was preferable to extend the neutral to embrace every transformer in the system. Where practical and necessary it might be possible to effect a combination of the two systems.

The report of the "Committee on the Fire Hazard of Electricity," was read by H. C. Wirt, chairman.

Of late the fire chiefs and officials of the country are beginning to realize, with a more intimate knowledge of electricity, the absurdity of assigning to electric wires every fire which no other possible case will fit. The report of "origin unknown" is more often given than the evasion "defective insulation"; nevertheless, on the candid statement of many fire authorities hundreds of conflagrations have been laid to the door of electricity, during the last five years or more, when any one of a thousand other causes were as probable and in many cases more so.

To reach a fair conclusion on the safety

of electricity as compared with other light, heat and power mediums, a territory is selected in which electricity is widely represented. New York city is unquestionably one of the most densely electrically supplied territories in the world. What is true of New York city should hold true in proportion the country over. Surely no better territory can be selected than this, in the little island where almost every wall and pavement hides its network of wires alive with current.

Compared with candles, gas and lamps, and the other chief illuminants of the metropolis, as shown at the outside, a comparatively small number of the total fires are due to electricity. In all Manhattan Island and The Bronx only 361 fires have been caused by electricity in the four years 1902, 1903, 1904, 1905.

Candles started almost four times, gas about six times, and lamps over twice as many fires as electricity. It is shown that 11.4 times as many fires were caused by the other three illuminants.

One-sixth of all the fires in the metropolis in four years are due to lamps, candles and gas, and approximately only one-seventy-fifth are due to electricity. While electricity caused only a little over one and a quarter per cent of all the fires in Manhattan and The Bronx in four years, it is credited with only a trifle over one per cent of the total losses.

In the report it has not been the object to minimize the fire hazard of electricity, but to show by actual comparison the relation of this hazard to that of other agencies supplying the same general class of service. The excellent showing is no doubt due in a great measure to the careful supervision of this subject by the insurance interests and the municipal authorities.

W. H. Merrill, Jr., secretary of the Chicago Board of Fire Underwriters said that it was very important that the association recognize the importance of the fire hazard. The appointment of an expert by the association to look into the matter and present truthful data on this subject would be a valuable adjunct to the association.

C. J. H. Woodbury closed the discussion on this paper, calling attention to the very small loss by fire in southern cotton mills for the last fourteen years, although the greater portion of them involving hundreds of millions of dollars worth of property were using electricity for light and power.

Percy H. Ingalls raised a question concerning the matter of patrolling signs in Chicago, in discussing the paper on "Free Electric Signs" which was then taken up.

A conservative estimate of electric signs in the United States places the number at 75,000, consuming an average of not less than 480 watts per hour each or a grand total of 36,000 kilowatts per hour. At an average of eight cents per kilowatt-hour the hourly income from these signs would be $2,880.00, the nightly income (averaging four hours per night) would be $11,520.00, and the yearly income a total of $4,204,800.

Of 1,188 stations, 158 made a special current rate for electric signs with an average reduction of 38½ per cent. Thirty-nine of these had free propositions and in these towns there was one sign to every 730 people. In the remaining 119 towns without free propositions, there was one sign to every 800 people. This, however, is not a full comparison, as income is what the station is interested in, and the income under the flat rate free proposition is much more per sign per year than under other circumstances.

The average for all sign current is slightly more than eight cents per kilowatt-hour. Assuming a cost delivered of three cents per kilowatt-hour for electricity at the average load factor of an electric sign load we have a full five-cent profit per kilowatt-hour. On the 52,560,000 kilowatts (estimated sign consumption) this would give a net income or profit of $2,628,000.00 per year.

John F. Gilchrist stated that it was the custom in Chicago in the congested district to charge for sign lighting on a flat rate and have patrolmen to switch on and off the lights at a cost of about six per cent of the sign income. In the outlying districts the signs were metered.

Percy H. Ingalls stated that the Public Service Corporation had about 600 signs on meter basis, requiring a minimum of $5.00 per month. The revenue for signs is doubling up very rapidly. The income reaches $6,000 per year for the 600 signs. It was his opinion that in exacting a minimum charge, whether the consumer used current or not, it effected a higher rate. The company had, however, practically decided to put the signs on a meter basis.

Mr. E. W. Lloyd stated that in Chicago the revenue for electric signs was some $300,000 per year. Recently nine sign salesmen had closed two-year contracts for 162 signs from which the net revenue would be $26,200.

The convention then went into executive session.

Morning and evening sessions were held on Thursday, June 7, the evening session being devoted to an address by E. W. Burdett, on "The Meaning and Proper Treatment of the Agitation for Municipal Ownership of Public Utilities."

OFFICERS ELECTED.

On Friday, June 8, the remainder of the technical papers were presented, and in the afternoon an executive session was held, including election of officers as follows:

For President—Arthur Williams, New York, N. Y.

First Vice-President—Dudley Farrand, Newark, N. J.

Second Vice-President—Alex Dow, Detroit, Mich.

Secretary and Treasurer—W. C. L. Eglin, Philadelphia, Pa.

Executive Committee to serve three years—Charles R. Huntley, Buffalo, N. Y.; F. M. Tait, Dayton, Ohio; L. A. Ferguson, Chicago, Ill.

On Tuesday evening a reception and dance was held in the ball-room of the Marlborough-Blenheim Hotel.

On Wednesday morning a sailing party made an ocean trip off Atlantic City, and on Wednesday evening there were several theatre parties. A. A. G.

Convention Notes.

THE National Electric Light Association had a busy time at its headquarters, which was established on the right of the entrance to Young's Pier. On Tuesday afternoon over a thousand attendants had registered. The exhibits were ranged along the front and sides of the pier, with the bandstand and seating arrangements in the centre. The uniform decoration of the booths was in white and gold, the corners of each booth being marked with an ornamental column surmounted by an incandescent globe lamp. The decorative effect was enhanced by the lavish use of incandescent lamps, and in many instances the exhibits were further enlivened with many colored electric signs.

Among the larger exhibits were the General Electric Company, Schenectady, N. Y.; the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa.; the Allis-Chalmers Company, Milwaukee, Wis.; the H. W. Johns-Manville Company, New York, N. Y., the Electric Storage Battery Company, Philadelphia, Pa.; the Gould Storage Battery Company, New York, N. Y.

The General Electric Company exhibited

a number of tantalum lamps with prismatic reflectors, and several sizes of the new "Gem" (metallized filament) high-power incandescent lamps with concentrating and diffusing reflectors. The company was represented by W. B. Potter, W. S. Murdy, P. D. Wagoner, H. J. Buddy, J. Scribner, S. F. Dibble, F. W. Wilcox, Frank H. Gale, A. D. Page, J. S. Anthony.

The Westinghouse Electric and Manufacturing Company made the most extensive and elaborate exhibit. This included many forms of motors and generators, measuring instruments, transformers, arc and incandescent lamps, Nernst lamps, Cooper Hewitt mercury vapor lamps and switchboards and switchboard materials. A feature of this exhibit was a large working model of a single-phase wattmeter.

The company was represented by the following:

L. A. Osborne, W. M. McFarland, C. S. Cook, S. L. Nicholson, C. B. Humphrey, Maurice Coster, W. C. Webster, W. F. Fowler, Paul T. Brady, Charles S. Powell, H. C. Stier, D. E. Drake, J. C. McQuiston, Fred W. Andrew, C. Aalborg, H. H. Van Staagen, G. R. Miller, H. W. Young, C. H. Bates, W. H. McGregor, C. C. Owens, C. R. Gilliland, Guy H. Gibbs, E. D. Miller, J. C. Warren, W. B. Jond, Wm. Bradshaw, T. S. Perkins, H. P. Davis, E. C. Means, C. C. Bassett, T. H. B. Whipple, Samuel A. Chase, A. M. Thackara, Jr., F. S. Watts, W. H. Martins, Lawrence Hoore, H. U. Rugg, Frank Smith, O. H. Miller, J. S. Lehman, and Messrs. Hayes and Stuart.

Sawyer-Man—Walter Cary, manager, H. V. Jackson.

Westinghouse Machine—E. H. Sniffin, third vice-president.

Nernst Lamp Company—Max Harris, general sales manager, C. W. Davis.

The Allis-Chalmers Company made a very attractive exhibit, showing a line of motors and generators. The showing of turbine parts attracted a great deal of attention.

The company was represented by C. A. Tupper, G. B. Foster, L. A. Harvey, E. F. Cassell, A. H. Whiteside, C. A. Wilkinson, L. E. Bogen, W. H. Powell, G. Strafer, F. L. Bunton, J. B. Nicholson, M. W. Thomas, J. C. M. Lucas, N. I. McCasky, F. C. Randall, H. A. Byrne and P. S. Gibson.

The American Instrument Company, Newark, N. J., exhibited a line of "American" round pattern switchboard instruments, models 1 and 2, and portable instruments, models 4 and 5. A complete series of switchboard shunts, up to 5,000 amperes, was shown. The 5,000-ampere shunt was fitted with General Electric terminals and the 2,000-ampere shunt with Westinghouse terminals. An interesting feature of this exhibit was a set of instruments with the top cover removed, showing the details of construction. An attractive exhibit was a model of the "American" pivot, exactly twenty times larger than the actual size. At one end there was a pivot of the actual size used in the instrument and at the other end the enlarged pivot. The company was represented by A. O. Benicke, J. G. Biddle and I. G. Seixas.

The Electric Storage Battery Company, Philadelphia, Pa., made an exhibit of large and small cells, an automatic refilling siphon, an indicating alarm hydrometer, and a twenty-point, 2,000-ampere end-cell switch, both motor-driven and manually controlled, and a drop-shutter indicating end-cell switchboard. Represented by H. B. Gay, Albert Taylor, I. J. Stone, E. L. Reynolds, G. H. Atkin and Charles Blizzard.

The H. W. Johns-Manville Company had a very attractively illuminated changing electric sign. The company showed a line of fuse specialties and fittings, service boxes and insulators. Represented by H. M. Vorrhis, A. D. Newton, S. G. Meek, Charles Brennen, J. W. Perry, C. N. Manfred, E. B. Hatch, W. A. White and R. C. Cole.

The Standard Paint Company, New York, N. Y., was represented by J. W. Richards, P. M. Wade, C. E. Smith. Samples of P. & B. air-drying and insulating varnish were shown.

The Phelps Company, Detroit, Mich., made a unique exhibit of "Hylo" lamps, demonstrating the turn-down action of various forms. Represented by the Hon. W. E. Phelps, president; W. J. Phelps, vice-president, and F. C. Gardiner.

The Dearborn Drug and Chemical Works, Chicago, Ill., exhibited samples of chemical compounds. Represented by George R. Carr, assistant general manager; H. G. McConnaughy and W. McVicker.

The Oneida Community, Limited, Oneida, N. Y., exhibited samples of chain for arc lamp suspension. Represented by Vernon W. Lee and S. R. Leonard.

The National Brake and Electric Company, Milwaukee, Wis., exhibited a line of motors and generators and air-brake apparatus. Represented by R. P. Tell, vice-president and general manager; W. L. Waters, J. T. Cunningham and S. I. Wailes.

The Gould Storage Battery Company, New York, N. Y., exhibited several sizes of cells for central station service. Represented by L. Littlefield, Jr., F. W. Halme, W. Powers and W. S. Gould.

The American Vibrator Company, New York, N. Y., exhibited electrical massage and vibratory apparatus. Represented by B. N. Small, vice-president; G. N. Wilcox, and J. F. O'Brien.

The Tipless Lamp Company, New York, N. Y., was represented by Herman Jaeger, president, and Richard S. Carrick, manager of sales.

The Buckeye Electric Company, Cleveland, Ohio, exhibited the "Buckeye" lamps, including a new tantalum lamp. Represented by L. P. Sawyer and J. M. Smith.

John L. Gleason, Jamaica Plain, Mass., exhibited a line of "Fancleve" patented specialties, including the Gleason moulding boxes. Represented by John L. Gleason and Reinhold Eberhardt.

The General Storage Battery Company, New York, N. Y., exhibited the "Bijur high-duty" battery and battery auxiliaries. Represented by F. E. Boos and R. C. Schaad.

The Southern Exchange Company, Maxton, N. C., exhibited samples of cedar lumber. Represented by E. G. Chamberlain, president; A. J. McKinnon, vice-president, and W. E. Mitchell, sales manager.

The Fort Wayne Electric Works, Fort Wayne, Ind., was represented by S. O. Ochs and Joseph Moulton.

G. M. Gest, New York and Cincinnati, exhibited various sizes of single and multiple duct, the Gest cable rack, and made the usual elaborate presentation of photographs of installations in all parts of the world. Represented by G. M. Gest and R. E. Brandeis.

The American Circular Loom Company, Chelsea, Mass., was represented by Alex. Henderson.

The American Electrical Heater Company, Detroit, Mich., was represented by B. H. Scranton, president, and Robert Kuhn, secretary.

The Crocker-Wheeler Company, Ampere, N. J., was represented by S. Russell and F. B. DeGrass.

The National Metal Molding Company, New York, N. Y., was represented by C. E. Corregan, vice-president, and J. A. Campbell.

The Philadelphia Electrical and Manufacturing Company, Philadelphia, Pa., was represented by Ray H. Manwaring and C. L. Bundy.

The Electric Service Supplies Company and Garton-Daniels Company, Keokuk, Iowa, were represented by W. E. Casper and H. E. Lewis.

The Simplex Electric Heating Company, Cambridge, Mass., made an elaborate display of heating and cooking utensils. Demonstrations were given and electrically cooked refreshments served. Represented by J. I. Ayer, C. W. Richards, C. H. Johnson and Roger Williams. The demonstrators were Mrs. H. M. Hyde and Mrs. F. M. Nichols.

The D. & W. Fuse Company, Providence, R. I., was represented by W. S. Sisson, secretary.

The Beck Flaming Lamp Company, New York, N. Y., was represented by Louis J. Auerbacher, president.

The Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass., exhibited arc lamps, circuit-breakers, current regulators and transformers. Represented by M. D. Barr, second vice-president; J. E. Cutler, manager New York office; A. H. Abell, manager switchboard and supply department; J. S. Codman, rate specialist; S. H. Blake, engineer arc lighting department; H. C. Rice, manager arc lighting and transformer department; A. W. Henshaw, manager motor department; A. Foster, of the Boston office, was in charge of the booth.

The Keystone Electrical Instrument Company, Philadelphia, Pa., was represented by J. F. Stevens, L. J. Costa, Arthur Organ and F. B. Smith.

The American Diesel Engine Company, New York, N. Y., was represented by Norman McCarty, general sales manager;

J. D. Macpherson, assistant chief engineer: Francis Head, Herbert B. Rust and G. F. Murphy.

The Automatic Refrigerating Company, Hartford, Ct., exhibited a complete refrigerating apparatus and ice-house. Represented by A. M. Young, A. C. Dunham, F. M. Kimball, A. W. Paige, J. I. Sargent, R. W. Rollins, K. R. McLaren and A. Michall.

The Fibre Conduit Company, Orangeburg, N. Y., showed sections of fibre conduit. Represented by W. W. Grant, vice-president, and W. W. Smythe.

The Wagner Electrical Manufacturing Company, St. Louis, Mo., exhibited transformers, single-phase elevator motors and controllers and switchboard and testing instruments. Represented by John Mustard, E. D. Pike, W. A. Layman, E. W. Goldschmidt, Brooks Faxon, W. A. Wyckoff.

The Shelby Electric Company, Shelby, Ohio, was represented by Frank M. Haskell.

A great interest was manifested in the new tantalum lamps which were shown or announced by the General Electric Company, the Brilliant Lamp Company, the Buckeye Electric Company and the Bryan-Marsh Company.

S. A. Douglass, E. F. Kirkpatrick, and C. C. Baird were busy making friends for the H. B. Camp Company, New York, N. Y.

The Moore Electrical Company, Newark, N. J., exhibited a 187-foot Moore tube light. This tube gave an illumination equal to about fifteen candles per foot, operated on a 220-volt circuit, 125 cycles, at an efficiency of 1.5 watts per candle.

The Atlantic Electric Light and Power Company made a handsome display of heating and cooking appliances and served refreshments.

The Sangamo Electric Company, Springfield, Ill., exhibited a line of Sangamo wattmeters and instrument parts. Represented by R. C. Lanphier and Thos. F. McKenna.

The Duncan Electric Manufacturing Company, Lafayette, Ind., exhibited a line of various forms of meters. The new Hornberger transformers of the Lafayette Electrical Manufacturing Company were also shown. Represented by Thomas Duncan and William H. Sinks.

The Federal Electric Company, Chicago, Ill., exhibited a fine line of unit signs. Represented by James M. Gilchrist, general manager, Federal Electric Company, Chicago, and William Norton, general manager, Federal Sign System, New York.

The Curtis Advertising Company, Detroit, Mich., exhibited an elaborate series of publicity services in the form of flyers, blotters, folders, letters and bulletins. Represented by C. H. Johnston, F. A. Curtis, Chas. A. Parker and Norman Miner.

Among the souvenirs distributed was a pencil holder by the D. & W. Fuse Company, a metal imitation cigar by the American Transformer Company, a miniature wood-planer by the Tipless Lamp Company, a very pretty and useful paper weight in the shape of a miniature wattmeter by the Sangamo Electric Company, a sample carbon from the Copley-Senior Carbon Company, a "Griptite" ground clamp by the Novelty Electric Company, watch fobs by the Allis-Chalmers Company, and a ground-connection clamp by the Chase-Shawmut Company, Newburyport, Mass.

Among those in evidence during the convention were the following: H. L. Shippy, treasurer, G. W. Swan, and Albert Mann, of the John A. Roebling's Sons Company, Trenton, N. J. Dr. W. M. Habirshaw and J. B. Olson, India Rubber and Gutta Percha Insulating Company, Yonkers, N. Y. Captain Willard L. Candee and R. Mace, Okonite Company, New York, N. Y. Charles E. Trump, Novelty Electric Company, Philadelphia, Pa. E. J. Kulas, Brilliant Lamp Company, Cleveland, Ohio. E. H. Haughton, and George G. Lockwood, Bryan-Marsh Company, Chicago and New York. John H. Dale and R. C. Heather, Dale Company, New York. John Campbell, president of the Electrical Auditing Company, Boston, Mass. W. M. Kerr, president Kinney Electric Light Display Company, New York. B. S. Barnard, president, B. S. Barnard & Company, New York. W. C. Banks, National Carbon Company, Cleveland, Ohio. Edmund J. Burke, Blake Signal and Manufacturing Company, Boston, Mass. Henry M. Shaw, Lord Electric Company, New York. Max Loewenthal, New York. Charles F. Munder, president and treasurer Munder Electric Company, Springfield, Mass. Rodwick J. Parke, consulting engineer to the Canadian government, Toronto, Can. Basil G. Rodjbanoff, manager Benjamin Electric Company, New York. I. P. Gleeson, St. Louis, Mo. L. Lobenthal, Economical Lamp Company, New York. M. N. Williamson, *Southern Electrician*. C. J. Purdy, American Incandescent Lamp Company, New York. R. A. Schoenberg, represented the Sarco Company, New York. This company equipped all the light on the pier with the "Sarco" "two-light" aluminum reflector. Blotters were also distributed, and the company gave away embossed display cards showing illustrations of the "Sarco" pendant switch, many of which were in use on various circuits; A. H. Patterson, vice-president and manager, and E. P. Ebberts, treasurer, Phoenix Glass Company, New York; F. E. Donohue, sales agent, American Electrical Works, New York; Henry D. Stanley, National India Rubber Company, Bristol, R. I.; Henry F. Vincent, Copley-Senior Carbon Company, New York; J. W. Brooks and W. B. Hall, Pass & Seymour, Solvay, N. Y.; James L. Russell, president, American Electric Sign Company, Boston; H. B. Kirkland, American Circular Loom Company; P. S. Klees, C. N. Thorpe and G. O. Curtis, Franklin Electric Manufacturing Company, Hartford, Ct.; D. D. Dickey, general manager; H. E. Hackenberg, treasurer; J. S. Crider, secretary; A. N. Barron, factory manager; J. F. Kerlin, assistant sales manager; A. E. Carrier, A. C. Henry, J. C. Irvine, F. C. Park, W. O'Conner, A. V. Ward, F. H. McDowell, C. W. Wilkins, F. J. Kysela, E. J. Kenny, A. D. Spear, W. C. Banks, National Carbon Company, Cleveland, Ohio; Charles M. Wilkins, treasurer, Patrick, Carter & Wilkins Company, Philadelphia; L. J. Costa and Arthur Organ, Jandus Electric Company, Cleveland, Ohio; Edward Keefer and H. S. Wilson, Western Electric Company, Chicago; C. J. H. Woodbury, Boston, Mass.; Captain I. H. Brady, New Britain, Ct.; Dr. Edward Weston, president, Weston Electrical Instrument Company, Waverley Park, N. J.; Henry F. Frosch, Chicago, represented the Chicago Electrical Show, which will be held in January; Frank B. Rae, Jr., represented the C. W. Lee Company, Newark, N. J., and distributed a practical pamphlet entitled "Application of Electricity."

Among the central station men present, many of whom had long been active in the work of the National Electric Light Association, were the following: William H. Blood, Jr., Arthur Williams, Dudley Farrand, W. C. L. Eglin, Ernest H. Davis, Samuel Scovil, A. J. De Camp, Joseph B. McCall, W. L. Mulligan, W. W. Freeman, A. H. Manwaring, Robert Humphries, Charles B. Hunt, J. Robert Crouse, D. F. McGee, S. E. Schwertzer, H. W. Sexton, Frank J. Baker, Malcolm M. Eckhardt, J. D. Harris, Joseph H. De Grange, Henry N. Muller, L. D. Mathes, W. B. MacDonald, J. A. Bendure, D. C. MacMonagle, Samuel C. D. Johns, J. C. DeLong, J. E. Hodgson, John L. Mather, R. B. Matthews, Douglass Burnett, W. N. Ryerson, J. A. Pearson, Byron I. Burton, A. J. Purinton, Philander Betts, F. M. Tate, W. E. McCoy, W. F. Wells, A. L. Selig, I. Fujioka, W. I. Barnes, J. M. Bradley, R. W. Rollins, E. J. Richards, M. G. Kennedy, M. E. Turner, W. A. Whittlsey, L. W. Emerick.

The full report of the last two days' sessions and additional convention notes will be printed in the next issue.

Social Features of the Convention of the American Institute of Electrical Engineers.

A full report of the technical meetings of the American Institute of Electrical Engineers held during the recent convention at Milwaukee, Wis., was given in the ELECTRICAL REVIEW for June 2. Besides these there were a number of exceedingly pleasant social features. On Monday evening an enjoyable reception was held at the Hotel Pfister, at which the local members welcomed the visitors.

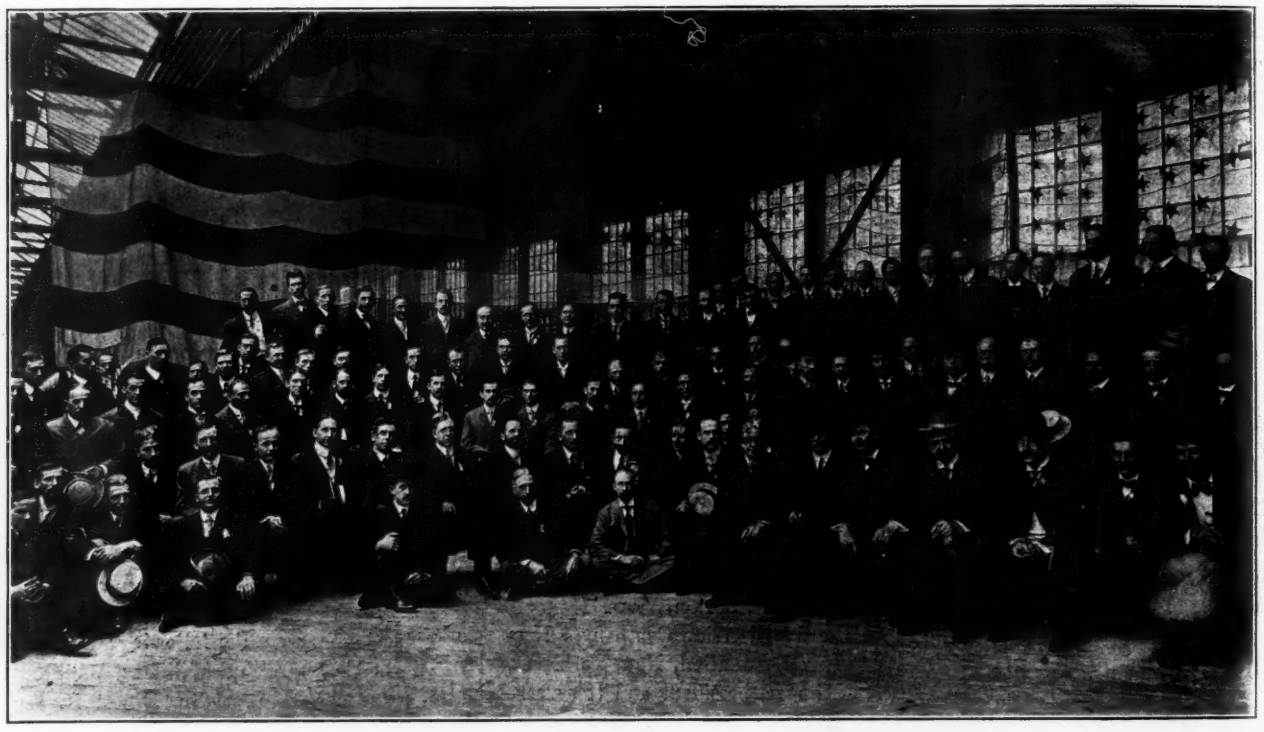
Tuesday afternoon special trolley cars carried the members of the Institute out to the works of the Allis-Chalmers Company at West Allis, about six miles west of the city of Milwaukee. Here they were received by officers of the company and conducted through the shops. A great deal of interest was excited by much of the work, particularly that of the steam turbine department and the large reciprocating engine shop. Here the frame for a large rolling mill engine, weighing 103 tons, was seen on a planer. This large casting was handled without any difficulty by the electric cranes which serve the entire works, although the load was considerably greater than that for which they were rated.

After passing through the shops a luncheon was served in one of the large new bays which have just been added to the works. The accompanying illustration was taken in this wing, and shows the visiting engineers.

There was nothing on the programme for Tuesday evening, this being given over to rest.

Wednesday morning and afternoon were taken up by reading and discussion of papers. In the evening a delightful dinner was given by the local companies to the visitors at White Fish bay, a beautiful lakeside resort a few miles north of Milwaukee. Special trolley cars were provided, and the greater number of the members went in this way, although some went by boat. As it had been thought desirable to transfer the meeting for the reading of papers, which had been planned for Thursday, to Wednesday afternoon, in order to enable those who found it necessary to get away before Friday morning to do so, it was necessary to abandon the dinner planned for Thursday night. For this reason the dinner at Whitefish bay took its place. President Wheeler acted as toastmaster, and a number of bright toasts were made, those speaking being Vice-Presidents C. P. Steinmetz and C. F. Scott, Paul M. Lincoln, H. H. Cutler, E. J. Prindle, F. Osgood, P. H. Thomas and R. W. Pope. At the conclusion of the dinner, resolutions were passed thanking the local committee and the local industrial companies for their hospitality. A good many of the members then visited the power-house of the Milwaukee Electric Railway and Light Company on Commerce street.

During the convention free telephone service was given to the members of the Institute from the pay-stations at the Hotel Pfister and the Plankington House by the American Telephone and Telegraph Company and the Wisconsin Telephone Company.



GROUP OF MEMBERS OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS IN ATTENDANCE AT THE ANNUAL CONVENTION, HELD AT MILWAUKEE, WIS., MAY 28–31. TAKEN IN ONE OF THE LARGE NEW BAYS OF THE ALLIS-CHALMERS COMPANY'S WORKS AT WEST ALLIS.

Thursday was given over to visits to the industrial plants in and near Milwaukee. Here the members were welcomed by the officers of the companies and shown through the works, interesting methods and apparatus being exhibited. The following were the plants visited: Allis-Chalmers Company, West Allis; Wisconsin Telephone Company, the Milwaukee Electric Railway and Light Company's power-houses, Semet-Solvay Company, Cutler-Hammer Manufacturing Company, National Brake and Electric Company, Pawling & Harnishfeger Varnish Company, Johnson Service Company, Nordberg Manufacturing Company, and the Fred M. Prescott Steam Pump Company.

The Power Transmission Line, and Third-Rail System of the Long Island Railroad.

By W. N. Smith.

THE lines first equipped comprise the Atlantic avenue division, between Flatbush terminal and Belmont Park, and the Rockaway Beach division, between Woodhaven Junction and Rockaway Park. The equipment of this latter division has also been extended to enable electric operation *via* Far Rockaway to Valley Stream.

A study of the traffic conditions to be met by the electrical equipment upon these divisions resulted in a preference for substation sites at Woodhaven Junction, East New York, Flatbush avenue, Rockaway Junction and Hammel. These were ultimately selected as permanent substation locations, except that Grand avenue, about one mile out from the terminal, was later on substituted for Flatbush avenue.

Two portable substations were also provided as the most economical method of supplying current for the very heavy periodic traffic to and from the Metropolitan race track, south of Jamaica, and the new Belmont Park race track, about five miles east of Jamaica. These loads occur for two hours each day for periods of two weeks, twice a year.

The portable substations consist of 1,000-kilowatt rotary converter outfits, complete with transformers and switchboard, each mounted in a heavy steel box car. A lightly constructed house, built of structural steel and enclosed with expanded metal and concrete, is provided at each site to enclose the terminals and shelter the portable apparatus when in use. From Rockaway Junction substation, one branch of the high-tension transmission line is run to the portable substation terminal house built at Belmont Park, and another to that at Springfield Junction.

The topography of the system is such that Woodhaven Junction substation becomes a natural distributing centre between the power-house and the other substations, and it was therefore decided to make it the objective point of a main power transmission trunk line which should bring directly to it the entire output of the power station for distribution among the substations. The problem of line construction was therefore to build a trunk line from the main power station to Woodhaven Junction, with two branch transmission lines running along Atlantic avenue between Grand avenue and Rockaway Junction, with two subordinate branches from Rockaway Junction to the two race tracks, and a third subordinate branch running directly south from Woodhaven to Hammel substation, across the Jamaica bay trestle.

The impracticability of constructing high-tension overhead lines in thickly populated sections of Brooklyn and Queens required recourse to underground construction in two sections of the line, one of them comprising one and one-eighth miles of the main trunk line, from the power station to Dutchkills street, and the other on Atlantic avenue between Flatbush terminal and Dunton, just west of Jamaica. Except where submarine cables were used, at the Broad Channel and Beach Channel drawbridges in the Jamaica bay trestle, the remainder of the transmission line is of the overhead type of construction.

The incoming trunk line circuits at Woodhaven Junction are distributed along a set of bus-bars called the "transfer bus," and divided into sections from which the outgoing transmission circuits lead in various directions. It is possible by manipulation of the bus junction switches to operate these circuits separately or together, from outlying substations all the way back to the power station. The same general arrangement is carried out in a smaller degree by similar transfer buses at East New York and Rockaway Junction.

The total mileage of conduit lines now in use is 9.09 and that of pole lines, 23.62 miles.

The duct line leading from the manhole directly outside of the Long Island City power station runs out Fourth street to West avenue, thence to Sixth street, which it follows to the railroad tracks. Thence it runs along near the northern edge of the railroad right of way to the arrester house at Dutchkills street.

This conduit line is constructed of single vitrified clay ducts eighteen inches long, with square holes three and thirteen-sixteenths inches inside measurement and walls three-quarters inch thick. They were designed especially for this construction, and the ducts are seven-sixteenths inch greater in diameter than usual, in order to facilitate the installation of the three-conductor high-tension cables, which are nearly three inches in diameter.

The ducts are laid in cement mortar in such a way as to break joints in all cases and are surrounded on the top, bottom and sides by a covering of concrete four inches thick, composed of one part Portland cement, two and one-half parts of sand and five parts broken stone. The ducts are arranged three wide and six high.

Manholes for drawing in and splicing the cables are located 400 feet apart on straight work and a shorter distance on curves. The standard manhole for straight line work is eight feet long, four feet wide and six and one-half feet high inside dimensions. The corners are cut off so that a horizontal section of the manhole resembles an elongated octagon. The side walls at the bottom are twelve inches thick and at the top six inches thick, reenforced with expanded metal. The manholes are built of concrete having a composition the same as that surrounding the ducts. An opening at the top is twenty-five inches square, and is closed by two covers, the inner one of which can be locked, clamped and packed gas tight if found desirable. Where, as sometimes happens, it was necessary to locate a manhole underneath the railroad tracks, it was strengthened by inserting additional I-beams in the roof. When the conduit line was placed between the edge of the right of way and the tracks, the limited space available made it necessary to change the shape of the manholes, which was done by making the side away from the tracks perfectly straight and about on a line with the outside row of ducts. The interior arrangement was in every case such that cables could be spliced and carried across from one duct to another without introducing any sharp bends or leaving the cables unsupported.

The underground high-tension cables are of the three-conductor type, each conductor having a cross-section of 250,000 circular mils and being composed of thirty-seven copper wires. Each conductor is covered with a wrapping of impregnated paper seven-thirty-seconds-inch thick. The interstices between the insulated strands are then filled in with jute insulation and another layer of seven-thirty-seconds-inch thick paper insulation is wound over the entire group. The outside sheath is nine-sixty-fourths-inch thick, and is composed of lead with about one and one-half per cent of tin added. The completed cable is two and seven-eighths inches outside di-

ameter. Each length of the cable was tested at the factory by applying 30,000 volts between each pair of conductors, and between each conductor and the sheath; and after the cable was installed in the ducts and jointed up ready for service, it was again tested by applying between each pair of conductors 30,000 volts, and between each conductor and the sheath 27,000 volts for a period of thirty minutes.

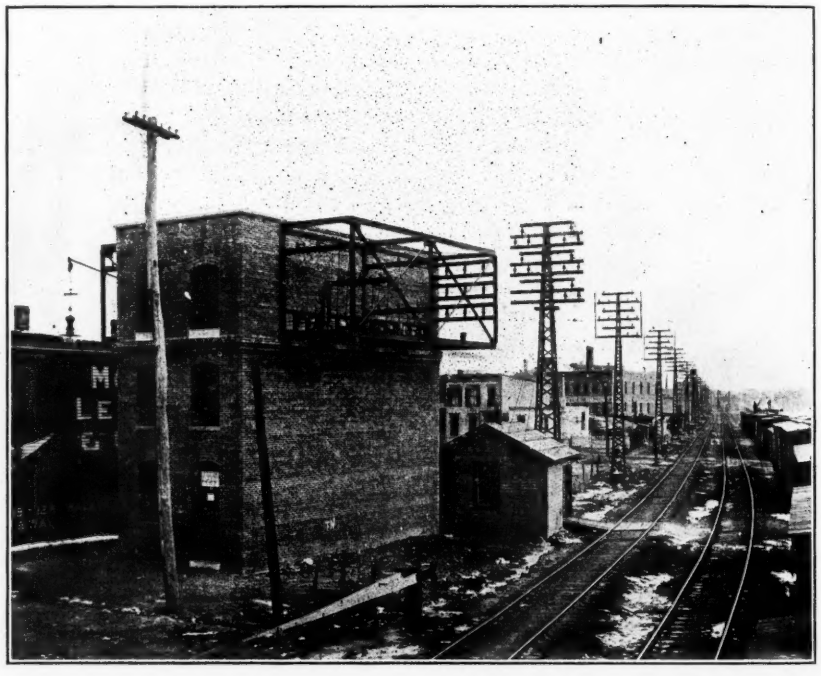
At each end of every high-tension cable there is sweated on a spun brass end-bell, which is filled with "No. 67" G. E. compound, to properly seal the ends of the cable and prevent injurious static discharges. The end-bell is about seven and three-quarters inches in diameter and about seven inches high. The three conductors are brought out separately through a wooden head in the end-bell, after being wrapped with varnished cambric tape, and are surrounded by micanite tubes to give additional insulation.

At the drawbridges in the Jamaica bay trestle, the cables are of the armored submarine type, and the conductors are insulated with seven-thirty-seconds of an inch of rubber around each strand with another seven-thirty-seconds of an inch of rubber around the group of three. This insulation is composed of thirty per cent pure Para rubber and is covered with a sheathing nine-sixty-fourths of an inch thick, and composed of lead with about one and one-half per cent of tin added, and over this is an armor of No. 4 B. & S. galvanized iron wires laid spirally on the outside of the lead covering with a thin layer of jute between the lead and the armor. There are two such cables at each drawbridge.

The high-tension cables are located in the lower portion of the conduit system, wherever possible, with the idea of separating them from any other cables for different purposes which may be installed subsequently. They are carried around the sides of the manholes in racks. The minimum radius of bend in this type of cable is eighteen inches. Where exposed in the manholes and at the substation terminals, the cables are wrapped with a layer of hard-rolled asbestos mill board one-eighth-inch thick, and outside of the asbestos mill board there is a wrapping of asbestos listing two inches wide, laid on until it averages three-eighths inch thick. The whole is then wrapped with galvanized iron tape one-sixty-fourth of an inch thick and one-half of an inch wide, laid on with edges overlapping. At each manhole there is a strip of sheet copper sweated on to the lead sheath and brought out through the wrappings to allow of grounding the cable should it be necessary to protect it from electrolysis.

The high-tension cables were all manufactured by the General Electric Company, and all except the submarine cables were drawn in, jointed and installed complete and ready for operation by the same company. There is in all about twenty-five miles of high-tension underground cable installed, besides 0.418 mile of armored submarine cable.

Wherever the underground cable section of the transmission line is joined up with the overhead system, lightning arresters and choke coils are installed, suitable houses being provided to shelter this apparatus, there being one on the main transmission line at Dutchkills street, Long Island City, and another at Dunton, on the branch line running east of Woodhaven. Smaller houses were also provided for the same purpose at the two drawbridges.



Long Island Railroad Electrification—Arrester House at Dutchkills Street.

The house at Dutchkills street is a brick structure, at present containing room sufficient for eight outgoing overhead circuits, which leave the house four on a side. The general design of the transmission line is such that the circuits on one side of the poles can be shut down for repairs without shutting down those on the other side, and this idea was carried out in the construction of the arrester house, so that there would be no confusion possible between live and dead conductors whenever it might become necessary to do any repair work on the line. The arrester house is thirty-three feet six inches in length, seventeen feet six inches wide and thirty feet six inches high inside, and is constructed of brick with a concrete floor and roof. Steel beams supporting the apparatus extend to the outside of the building, forming a series of racks for the support of the transmission cables which are dead ended upon them. The arresters are all provided with knife switches, so that they can be readily disconnected from the circuit. A choke coil is also provided in series with each main circuit, and another knife switch between the choke coil and the cable bell, enabling the cable to be entirely disconnected from the overhead line. Wood has been entirely omitted from the construction of this arrester house, making it fireproof. The incoming cables are carried through the floor by means of ducts reaching to the last manhole in the conduit line, and are arranged along the wall, running through switches and through the choke coils to the various outlets along the various portions of the outside walls. The arresters are mounted on either side of the steel framework in the centre of the building, and the ground connections all run to a single ground lead consisting of five and one-half square feet of copper plate buried in the ground between layers of crushed coke. The arresters are of the Westinghouse low-equivalent type, mounted on marble slabs, which in turn are carried upon porcelain insulators.

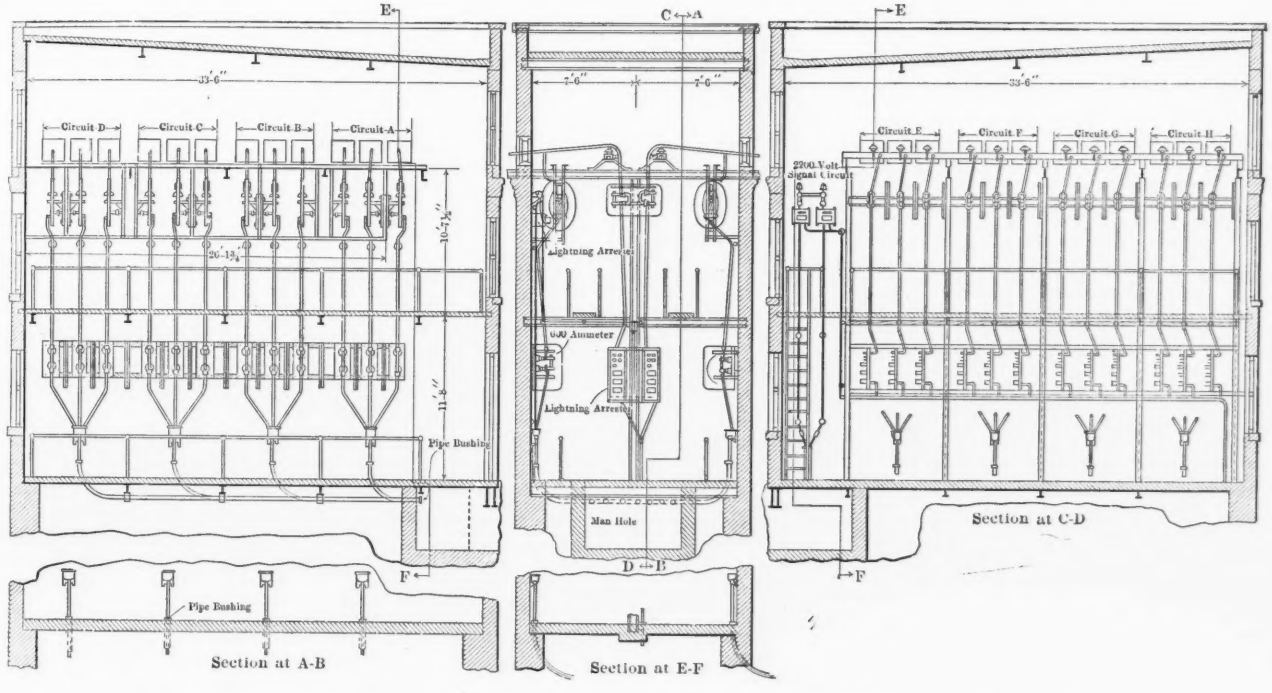
The outgoing cables on each side are

anchored on a strain pole after leaving the racks upon the sides of the building, which in themselves are not intended to carry the longitudinal stresses of the overhead cables.

The opening in the side of the house through which the cables run are eighteen inches square, enclosed by two glass plates three-eighths of an inch thick and separated five inches with two and one-half-inch holes in the centres, through which the cable passes without touching the glass. A thin disc of brass two and one-half inches in diameter is attached to each wire midway between the glass plates, and thus prevents the direct access of rain or snow through the openings. Standard straight line insulators are used for supporting the bare wires inside of the building.

A similar house to the foregoing is located at Dunton, where the branch transmission line running eastward from Woodhaven is changed from conduit to overhead construction. The design of this house and the arrangements of the apparatus inside it are identical with the one above described, but with capacity for six circuits instead of eight.

At the drawbridge channels in Jamaica bay three houses are provided to shelter similar apparatus. These each consists of a steel framework covered with expanded metal and concrete side walls and a corrugated copper roof resting upon a pile foundation. The method of entrance of wires is similar to that above described and the strains of the overhead line are taken by a separate anchorage composed of four poles braced together, forming a stiff wooden tower which carries the longitudinal strains of the line without guying. The pile foundation is protected from ice by clusters of fender piles suitably located around them. There are two of these houses at Broad Channel and one for the north side of Beach Channel, as the south end of the submarine cable at the latter place after passing to the shore runs through ducts directly to Hammel substation, which is only a few hundred feet from the drawbridge.



Long Island Railroad Electrical Equipment—Arrangement of Apparatus in Lightning Arrester House.

There are two general divisions of the overhead construction, the trunk line between Dutchkills street and Woodhaven Junction and the branch lines between that point and the other outlying substations. The trunk line is built of steel poles and the branch line between Dunton and Rockaway Junction, through which the latter substation and two portable substations are fed, and upon which the circuits to stations not yet constructed may eventually run, is also equally important with the trunk line and is therefore built of steel. From Rockaway Junction the branch pole lines to the separate outlying substations are of wood. From Woodhaven Junction south the poles are of steel to the southern outskirts of Ozone Park, because of the rather exceptional height at which the cables have to be carried to clear other wires, but from Ozone Park to Hammel they are of wood.

The steel poles are of various sizes to meet differing conditions. They are all designed to carry twenty-four 250,000-circular-mil cables on their upper portions, and underneath them an additional load of eight 500,000-circular-mil low-tension cables, which local regulations require to be at least twenty-five feet above the ground. The spans between steel poles average 150 feet in length, except where turning corners or carrying the cables over railroad tracks. The poles, when fully loaded as above, are able to carry safely a weight of 4,500 pounds of cable. The steel poles are built of four corner angles, connected together by angles and plates forming a lattice type of construction. They are tapered uniformly to the top on two sides and to within about seven and one-half feet of the top on the other two sides, the taper being three-eighths inch per foot. This taper is uniform to the bottom of the pole, and is the same for all lengths of poles. The tops are in every case six by eleven inches. At the bottom the corner angles are tied to a base composed of plates and channels through the corners of which the four anchor bolts pass. This forms a sort of box construction around the base of the pole, and greatly increases its stiffness

and stability. This type of construction enables a foundation to be built and the anchor bolts set at any convenient time independent of the delivery of the poles. This permits the most desirable degree of flexibility in the organization of the pole-setting force, thus dividing it into practically two separate gangs, neither of which is hampered by the movements of the other.

The standard poles are made in four lengths, increasing by five feet from thirty-nine feet to fifty-four feet in length, the thirty-nine-foot pole being the standard, the other lengths being only used where necessary.

The poles are designed to withstand a wind pressure at right angles to the line corresponding to a wind velocity of 100 miles per hour. This was calculated from data obtained in the Berlin-Zossen high-speed railway tests, which showed the pressure on a flat surface due to a wind velocity of 100 miles per hour to be about twenty-seven pounds per square foot, which applies to the flat surfaces of poles and cross-arms. For the projected area of cylindrical conductors one-half of this value or thirteen and one-half pounds per square foot was the factor used for the above wind velocity.

Besides the standard poles above described, designed to meet the ordinary conditions, an extra heavy pole was designed in three lengths. This type is called the strain pole and is used for offsets up to thirty-two and one-half feet for turning sharp corners, or for anchoring the line at special points. These poles are similar in design to the standard poles, but the taper is uniformly increased to one-half of an inch to the foot, and all four sides taper uniformly all the way to the top, which is eight and one-half by twelve inches.

The wooden poles are of two kinds: chestnut, which is the standard for ordinary work, and creosoted yellow pine, which is used only along the trestle over Jamaica bay. The chestnut poles are forty-five, fifty and fifty-five feet in length and twenty-five inches in circumference at the top. The creosoted poles are from sixty to eighty feet long, with the same dimensions at the top, and treated with fifteen pounds of dead oil of coal tar per cubic foot of timber. Creosoted poles are all set fifteen feet into the bottom of the bay by means of a water jet. They are all set so as to have the tops thirty feet above the rails and are located far enough away on one side of the trestle to obviate any interference with the wires on the part of the pile driver that is used to renew the piles of the trestle bridge. These poles were braced to the trestle with creosoted yellow pine timber.

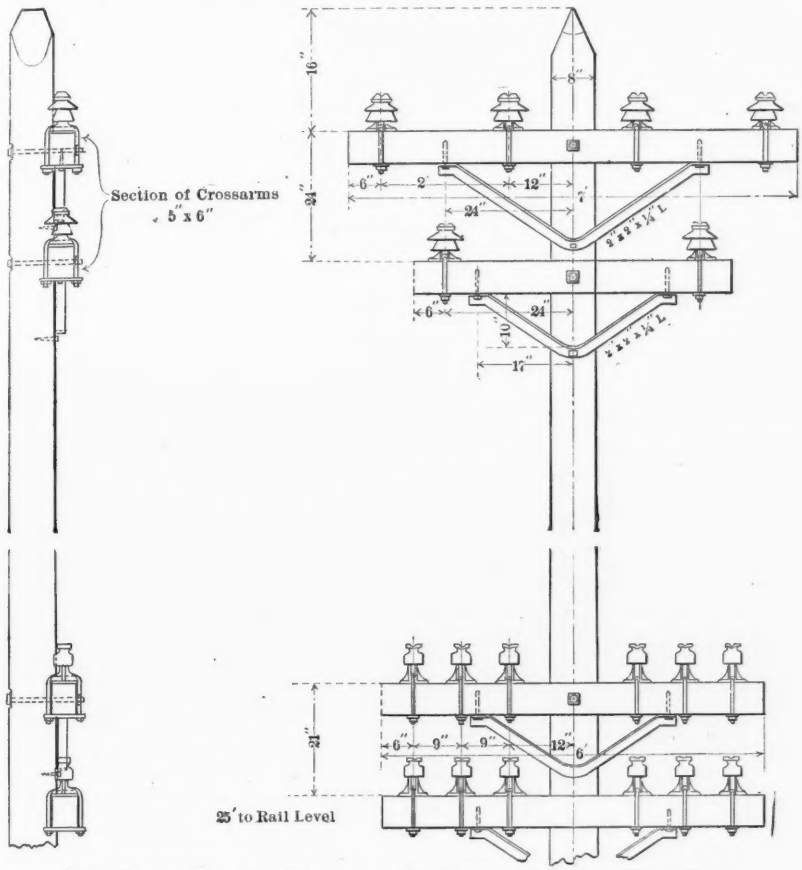
LONG ISLAND RAILROAD ELECTRIFICATION—MAIN OVERHEAD LINE NEAR WOODHAVEN JUNCTION.

The total number of steel poles employed is 377, of chestnut poles 490 and of creosoted yellow pine poles 264.

LONG ISLAND RAILROAD ELECTRIFICATION—WOODEN POLE CONSTRUCTION ON JAMAICA BAY TRESTLE.

The cross-arms are of yellow pine five by six inches cross-section, housed on top to a twelve-inch radius, and they are painted with one coat of asphaltum paint. The method of attaching them to the steel poles has already been described. On the wooden poles they are gained one inch into the pole and held by one three-quarter-inch through bolt with two-inch square washers. Bracing, though unnecessary on the steel poles, was effected in the case of wooden poles by angle iron braces made

in one piece of two by two by one-quarter-inch angle bent into V-shape. For standard steel poles the arms are seven and nine feet long. For steel strain poles they are seven feet ten inches and ten feet six inches.



LONG ISLAND RAILROAD ELECTRICAL EQUIPMENT—STANDARD WOOD POLE.

The insulator pins consist of malleable iron castings clamped to the cross-arms by means of U-bolts threaded through the body of the pin and held by a plate fitting over the U-bolts and against the cross-arm. This type was first used on this transmission line and represents a new departure in pin design, inasmuch as by its use all boring of the cross-arm is avoided. The strength of the cross-arm is maintained and the depreciation resulting from entrance of moisture through holes bored in the arm from top to bottom is obviated. The form of pin used is also of much greater strength than is possessed by a pin in which the bending moment where it enters the arm has to be met by small cylindrical cross-section, which in case of the iron pin is sometimes not more than three-quarters of an inch in diameter and in a wooden pin one and one-half inches to two inches. The strongest part of this pin is at the base, where it joins the cross-arm.

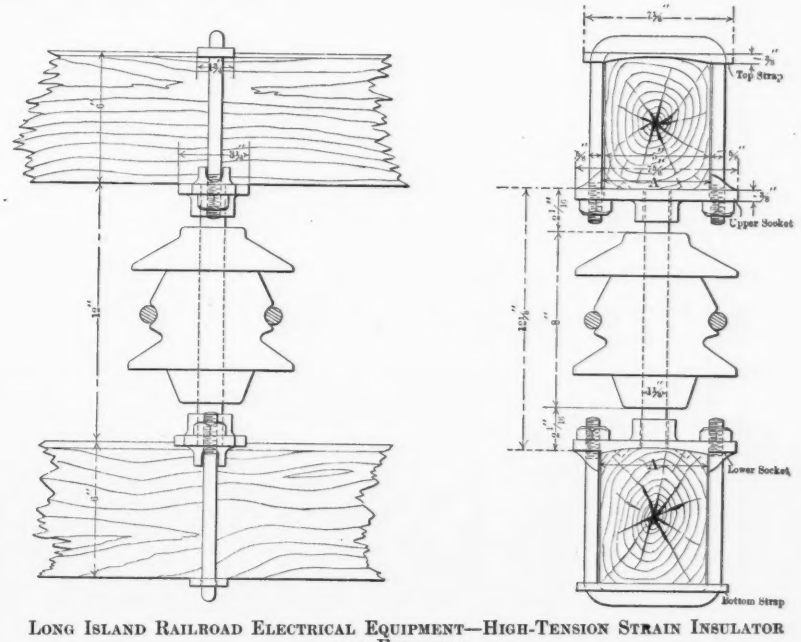
This pin has proved highly successful in practice, and application has been made by the inventor, W. N. Smith, for a patent covering the design.

The straight line insulators are six and one-half inches in diameter and five inches high, made of porcelain, in two parts cemented together. The insulators are colored with a brown glaze to render them less conspicuous. They are designed particularly for the conditions here imposed and were furnished by R. Thomas & Sons. The pin and insulator together carry a 250,000-circular-mil cable six and one-half inches above the cross-arm. The ties are made of ordinary soft copper wire, tied on top.

The strain insulators are of the "spool" type and made in one piece seven and one-half inches in diameter and eight inches high. Each strain insulator has two petticoats, one above and one below the point where the wire is attached. A one and one-eighth-inch by twelve-inch steel pin is cemented in the centre of the insulator, and this steel pin rests in sockets at the top and bottom which are firmly clamped by U-bolts to the cross-arms.

The transmission cables are of 250,000-circular-mil stranded copper and are fastened to the insulators with ties of No. 6 copper wire three feet long. Splices were made by cutting back the core of the cable and wrapping the outer layers of strands around the abutting cables, after the manner of the ordinary Western Union splice. All the joints were soldered. Where jumpers were used to lead into substations or arrester houses, the ordinary half connection joint was made and carefully soldered.

The total amount of overhead transmission cable erected is 62.03 circuit miles, or 186.09 miles of cable. This cable was furnished by the Standard Underground Cable Company.



LONG ISLAND RAILROAD ELECTRICAL EQUIPMENT—HIGH-TENSION STRAIN INSULATOR AND FASTENING.

No low-tension cables were required for the initial installation except to connect

up isolated sections of third rail where it became necessary to break the third rail at switches and crossings. There are, therefore, no low-tension cables on the poles at present, but when installed they will be carried upon heavy porcelain top groove insulators and pins of the same general type as described above.

Wherever the power transmission circuits cross the highways or railroad tracks special precautions are taken to ensure against the possibility of a cable falling off a cross-arm and hanging down in position to endanger passing traffic. At such points the spans are shortened as much as possible. In some cases an extra straight line pole is used in the line and at other points a strain pole is placed on each side. Wherever the wires cross other electric circuits the high-tension wires are carried above the others, as their large size and strong mechanical supports make them less liable to fall upon others than would be the case if their positions were reversed. At all crossings and over station platforms, and on the inside of curves, vertical angle irons, called "retainers," are bolted to the ends of the cross-arms, so that in case of the insulator breaking or cross-arm burning off the wire can not fall any distance away from its normal position.

After the line was finished the railroad company installed a telephone line, which is carried on the same poles that support the power circuits and connects the power-house with all the substations. It also has instruments connected to it and mounted in boxes at intervals of about 2,000 feet, which are used by the men patrolling the line.

At the Woodhaven and Rockaway Junction substations special terminal poles or racks are provided to distribute the overhead circuits along the face of the building parallel to the high-tension switching galleries in such a manner that the disposition of the cables after entering the building will be most convenient.

A study of the equipment clearances pointed to the necessity of locating the third rail with its centre twenty-seven inches from the outside of the gauge line of the running rail and its top at a height of three and one-half inches above the top of the track rail. After considering a great variety of designs, both of rails and contact shoes, it was decided to adopt the top contact type which is now almost universally employed. In order to best combine the qualities affording protection to employés and immunity to weather troubles, it was decided to provide a horizontal type of guard extending directly over the rail, requiring the use of the slipper type of contact shoe. With this type of contact rail a tee section was naturally adopted on account of its stability. The location of the contact rail with reference to the track was also governed by the fact that it could not be placed much farther away from the track rail without interfering with bridge gussets and other fixed objects, while, if placed higher, the guard would be interfered with by fifty-ton hopper-bottom steel coal cars when heavily loaded.

The rail used for most of the construction is a modified tee shape weighing 100 pounds to the yard in thirty-three-foot lengths. The section is four inches high, with a head three inches wide, bottom flange six inches wide and web one and one-half inches thick.

The rail is of extra soft steel, as will be seen by the following analysis: carbon, 0.08; silicon, 0.074; phosphorus, 0.074; sulphur, 0.029; manganese, 0.022.

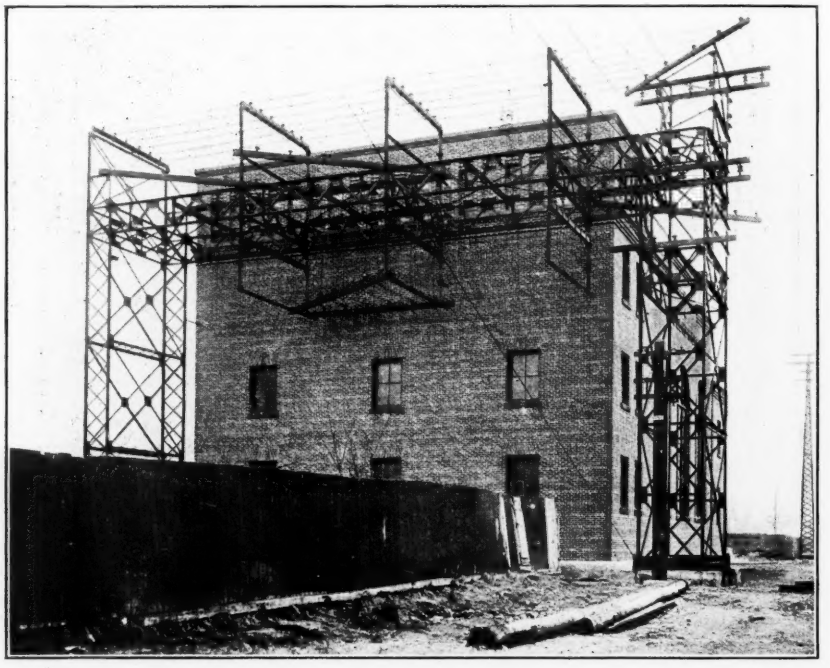
The resistance of the sample in the above analysis is by measurement for a 100-pound section, equivalent to 1,650,000 circular mils of copper.

All of the main line tracks on the elevated line are provided with this 100-pound third rail, excepting about seven and one-half miles, which are fitted with seventy-pound standard relaying T rails. For sidetracking and unimportant spur work sixty-pound relaying rails were used.

Splice bars are of rolled steel eighteen inches long, with four holes carrying bolts three-quarters by three and three-quarters inches. They were rolled especially for the third-rail section adopted, and, as they are not subjected to unusual strains, were made of the minimum weight suitable for a third-rail fastening. The unusual breadth of the base of the rail allows ample space between the splice bar and the edge of the flange to accommodate the head of the compressed type of rail bond. On the seventy-pound and sixty-pound rails such was not the case, and the splice bars were notched out to accommodate the bonds.

The contact rail is supported every ten feet on vitrified clay insulators set on extra long ties. The insulator consists of a cylindrical piece of vitrified clay with a beveled flange projecting at the base and a two-inch hole through the centre to aid in manufacture. A malleable-iron ring having two projecting lugs and holes in each lug for lag screws fits over the flange at the base of the insulator, two lag screws being used to fasten it to the tie. Resting on top of the insulator is a malleable-iron cap which projects down over it for a distance of one and one-eighth inches and has two ears one and one-quarter inches long projecting upward. The rail rests on top of the cap between the ears.

The end approach blocks and inclines for lifting the third-rail shoes are of cast iron. Two lengths are used, one being five and one-half feet long and used on main line tracks where the shoes must be raised and lowered at high speed;



Long Island Railroad Electrification—Terminal Cable Rack at Rockaway Junction.

while the other, which is two and one-half feet in length, is used only on spur track and sidings. The approach blocks are attached to the end of the rails by the regular splice plates and are supported on standard third-rail insulators at their outer ends.

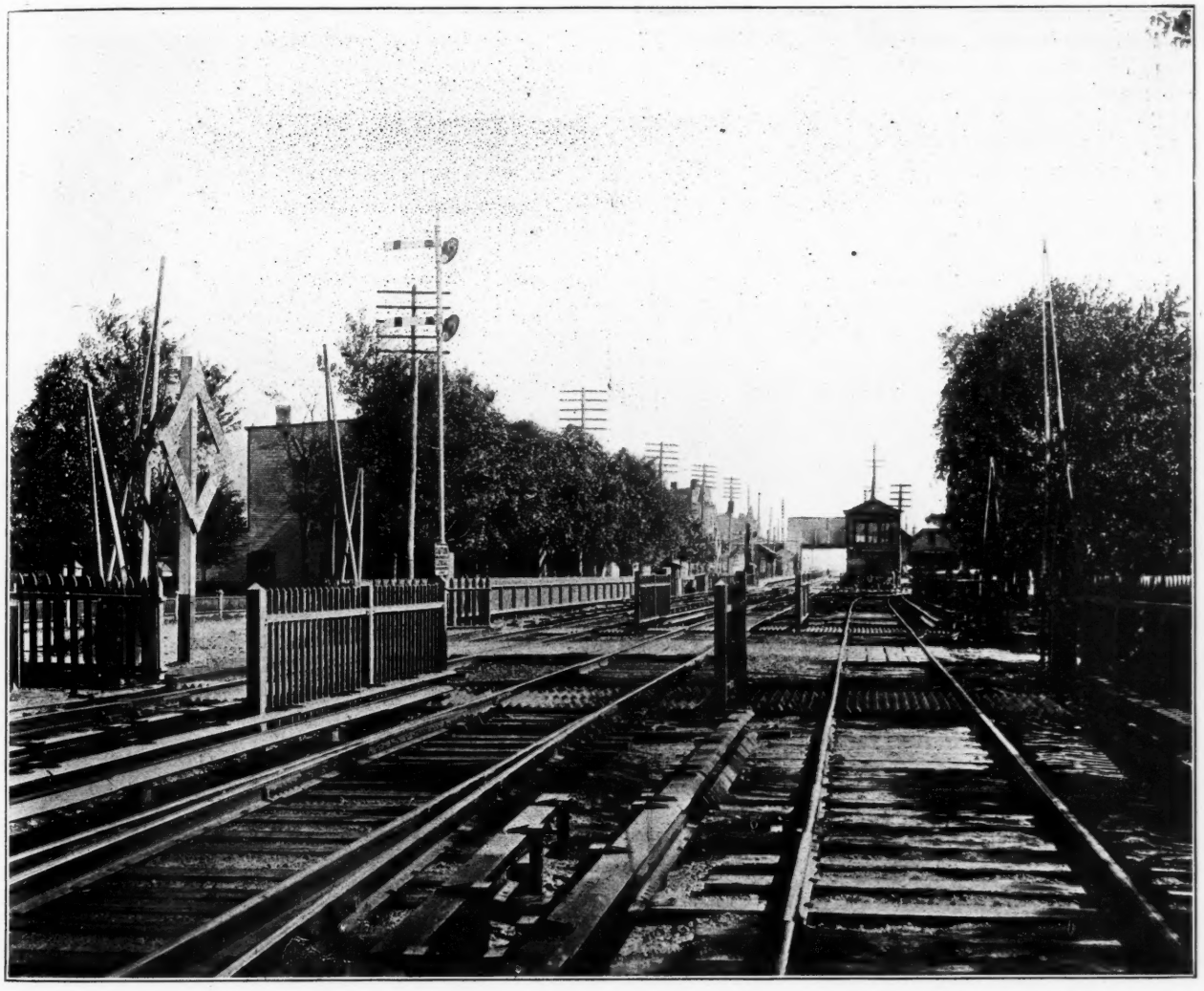
The third-rail joints are bonded by laminated copper foot bonds with plug terminals, of Mayer & Englund manufacture. They are varying sizes, according to the weight of the rail to which they are applied, 300,000, 350,000 and 400,000-circular-mil sizes being employed.

The third rail is frequently interrupted by highway crossings and switches, and at such places underground cables are provided to maintain its electrical continuity.

As at present installed the third-rail system is not fed in separate sections from the substations, but is treated as a continuous conductor between substations, except where the number of switches and cross-overs incidental to a station terminal or junction necessitate dividing it into sections that can be easily isolated from the remainder of the third rail should emergency require. There are, therefore, no low-tension cables running along the tracks to reenforce points distant from the substations, but the frequency of highway grade crossings and track switches and crossovers requires the frequent interruption of the third rail. To maintain its electrical continuity at such places underground jumper cables are provided.

These cables are in three sizes, 500,000 circular mils, 1,000,000 circular mils and 2,000,000 circular mils. The cable is insulated with varnished cambric four-thirty-seconds of an inch thick which is covered with a lead sheath one-eighth of an inch thick for the 1,000,000 and 2,000,000 circular mils and three-thirty-seconds for the 500,000-circular-mil cable. Outside of the lead there is a layer of prepared paper and two layers of jute wound on spirally in opposite directions and thoroughly impregnated with asphalt. The ends of the conductors are connected to the third rail by having sweated upon them special brass terminal lugs, each lug having sockets for four 400,000-circular-mil flexible cables. Short cable bonds, each with a copper plug terminal drop forged on one end, are soldered into the socket, and after pigtailing these terminals to provide flexibility the plug terminals are compressed into holes in the base of the rail. The number of bonds used in each case varies with the size of the cable, being four for the 2,000,000-circular-mil cable, two for the 1,000,000-circular-mil cable and one for the 500,000-circular-mil cable, in which case the bond is soldered by means of an ordinary sleeve connection to the cable.

All cables for third-rail connections were



LONG ISLAND RAILROAD ELECTRIFICATION—THIRD-RAIL CONSTRUCTION, FENCES, GATES, AND CATTLE GUARDS, AT GRADE CROSSING—ATLANTIC DIVISION.

furnished by the General Electric Company.

The Stillwell-Slater type of guard was adopted for the third rail; it consists of yellow pine plank one and seven-eighths inches thick, seven inches wide, placed above the rail with two and one-half-inch clear space between the top of the rail and the underside of the plank. The edge of the plank nearest the track extends seven-eighths of an inch beyond the line of the third-rail head and is beveled back to give the necessary clearance for running equipment. Each plank has a saw cut three-eighths of an inch deep in the middle of the underside to prevent warping.

At the drawbridges in the Jamaica bay trestle the third rail is interrupted, and to maintain this continuity three submarine cables are installed, one for each third rail and one as a spare. These cables consist of 2,000,000-circular-mil copper core insulated with four-thirty-seconds of an inch of thirty per cent Para rubber encased in a lead sheath one-eighth of an inch thick, and armored with one layer of No. 4 B. & S. galvanized-steel wire laid on spirally with a layer of jute covering.

The short length of third rail on the drawbridge is connected by brass contact shoes, which make connections at each end of the draw when it is closed.

The cables connecting the third rail with the substations are all of 2,000,000 circular mils, and connections are made directly in front of the substations. In some cases these short feeders are located in conduit and in other cases laid directly in the ground in the manner above described for the crossing jumpers. Such cables, when laid in ducts, are insulated with five-thirty-seconds of an inch of paper, covered with a layer of sheathing one-eighth of an inch thick.

Near each substation the third rail is interrupted by a forty-foot gap. Should any section break down it is then impossible for a single car to bridge the gap between the live rail and the grounded one, thus avoiding the possibility of injury to the car wiring and equipment. The east and westbound tracks are in most cases supplied by a separate set of feeders and are not cross-connected except through the station bus-bars. Current can therefore be cut off from the section of either track lying between two substations simply by opening the proper feeder switches in the stations at each end of the section.

In order that part of a section between two substations may be disconnected in case of emergency instead of requiring the whole section to be thrown out of service, 1,600-ampere disconnecting switches are installed at suitable intervals between substations being cut into the third-rail circuit, so that by opening any two of them the section between them can be cut out, though normally these switches are kept closed. They are generally located near the cross-overs to enable trains to switch around the opened section on the other track. The switches are of the quick-break knife-blade type and are located in wooden boxes fastened to the third-rail guard.

There are several very important places on the line where the arrangement of interlocking switches is such as to require special provision for cutting the third rail into sections. Woodhaven, Ozone Park, Jamaica and Hammel are points where the arrangement of intersecting and side tracks is such as to require this special treatment.

Both running rails of each track are used for the return circuit. On a considerable portion of the line an automatic block signal system is used requiring the use of both running rails for its operation so that a special method had to be used in order to allow the tracks to be used jointly as a power return circuit and for signal purposes. The signal system was developed by the Union Switch and Signal Company and employs alternating current for the operation of the signals. With the aid of a special arrangement of bonding the track is used for carrying both direct and alternating current without the former affecting the latter.

The problem of bonding the rail joints was solved by different methods on different portions of the line, depending largely upon the local conditions. The rails having been practically all laid when the work of equipment began, the type of joint plate then in position had much to do with the various types of bonds employed.

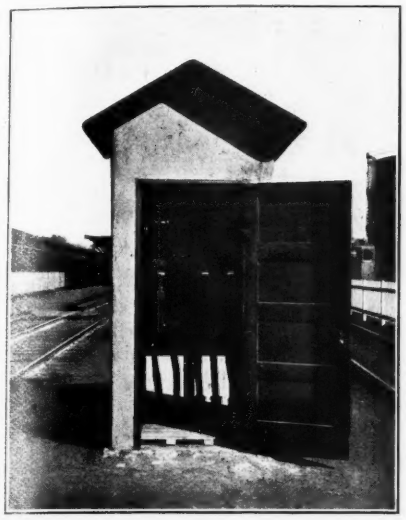
A good deal of the bonding was done with laminated bonds of the soldered type, attached to the ends of each splice bar, requiring four bonds per joint. The bonds have a cross section of 486,000 circular mils and are one-fourth of an inch thick, and two inches wide composed of successive layers of copper ribbon. They were furnished by the Lord Electric Company.

LONG ISLAND RAILROAD ELECTRIFICATION—STANDARD THIRD-RAIL CONSTRUCTION ON ATLANTIC AVENUE ELEVATED STRUCTURE.

In the tunnel sections cable bonds forty-five inches long spanning the splice bar and with terminals compressed into the rail webs were used. These are of 350,000 circular mils cross section and three are installed per joint, as the rail is of 100-pound section. On the elevated portion of the line and on the Jamaica bay trestle, the guard rails which are fifty-six pounds per yard are bonded together and used as a part of the return circuit. The bonds used for these rails are also of the soldered type built up of copper ribbon and fastened to the side of the rail head. They have a cross section of 560,000 circular mils per joint.

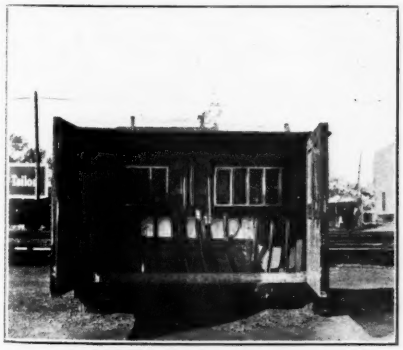
Where the automatic block signal system is used, it is not possible to cross bond the running rails on account of the

disturbance in the signal system which would thereby be occasioned. On other portions of the line two 350,000 circular mils bonds of the plug terminal type were installed between the rails of the same track and between adjoining tracks at



LONG ISLAND RAILROAD ELECTRIFICATION — SWITCH AND CIRCUIT-BREAKER HOUSE FOR THIRD-RAIL CIRCUITS.

intervals of about 1500 feet. A special arrangement was devised for cross bonding a portion of the line where the automatic block signal system is used. The cross connections only occur at the end of the signal blocks where the special inductive bonds are cut into each track rail. These inductive bonds serve to keep out signal current, but for the direct current, act exactly the same as the ordinary bond, and maintain the continuity of the running rail. The cross connections be-



LONG ISLAND ELECTRIFICATION—SWITCH AND FUSE HOUSE, CONTROLLING THIRD-RAIL SECTIONS.

tween the tracks are made at these points, the inductive bonds being used in both tracks so that the signal system is not affected by the flow of current between them.

At the two drawbridges in the Jamaica bay trestle, the continuity of the return circuit is maintained by four 2,000,000 circular mils rubber covered armored cables at each crossing similar to those used for the third-rail circuit and connected up to the rails in like manner.

The feeder connections between the track rail and the negative bus-bar connections in the substations are 2,000,000 circular mils bare tinned copper cable. In some cases these cables are buried directly in the ground without protection, while at others, they run in vitrified clay ducts.

The completed overhead line was first put in service on April 27, 1905, and the third rail was first put in service about May 13, 1905. Regular operation began July 26, 1905. The operation of the transmission line and the third rail have been remarkably free from interruptions of whatever nature, and have demonstrated their efficiency as a substantial and reliable transmission system for a suburban railroad on whose regularity of operation thousands of people are daily dependent.

The design and construction of the foregoing transmission system was carried out by Westinghouse Church Kerr & Company, engineers for the Long Island Railroad Company, and the entire work was under the direction of George Gibbs, chief engineer of electric traction of the Long Island railroad, subject to the approval of an electrical committee, consisting of the chief operating officials of the road, with the president as chairman.

New York City-Interborough Railway.

At the annual meeting of the New York City-Interborough Railway Company, E. P. Bryan was elected a director to succeed J. J. Rollins, and Herbert H. Vreeland, to succeed D. W. McWilliams. The following directors were reelected for the ensuing year: Arthur Turnbull, Andrew Freedman, Alfred Skitt, W. G. Oakman, Cornelius Vanderbilt, Robert C. Wood and W. J. Fransioli. The board elected the following officers: president, Alfred Skitt; vice-president, Andrew Freedman; secretary, H. M. Fisher; treasurer, D. W. McWilliams.

Visiting Engineers to Attend Opening of Electrotechnical Laboratory in London.

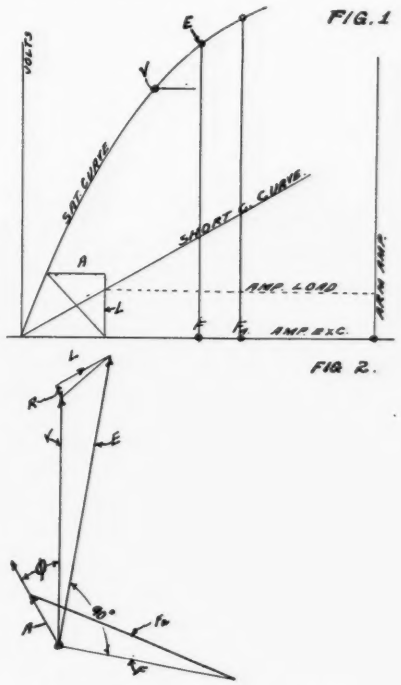
Mr. R. B. Haldane, the British secretary of state for war, will open on June 25 the buildings which have been added to the National Physical Laboratory for electrotechnical and photometric work. This is the first day of the tour of the members of foreign societies received by the Institution of Electrical Engineers of Great Britain, and they will be invited to attend the ceremony.

HEAT TESTS ON ALTERNATORS.[1]

BY SEBASTIAN SENSTIUS.

Every electrical factory occasionally produces an alternator of a size which does not admit of a heat test under normal conditions of operation, unless there happens to be another alternator of about the same capacity and voltage entering the testing floor at the same time.

In such a case the testing engineer has to resort to methods of tests which require a supply of energy approximately equal to the losses under normal operating conditions. Among those generally applied, Mr. B. A. Behrend's apparently is the simplest. It merely consists in short-circuiting the stator winding and in opposing one-



HEAT TESTS ON ALTERNATORS.

half of the field winding to the other, each half being separately excited. The separate excitation makes it possible to limit the unbalanced flux to an amount sufficient to circulate the current through the stator winding. Numerous tests have proved that vibrations due to the unbalanced flux are practically harmless.[2]

It is unfortunate that the test just described may be applied only on alternators with more than eight poles, eight being the lowest limit. And since the modern alternator design points toward the adoption of a few number of poles (turbo-alternators) it becomes imperative

[1] A paper presented at the Twenty-third Annual Convention of the American Institute of Electrical Engineers, Milwaukee, Wis., May 28-31, 1906.

[2] Trans. Int. El. Congress, St. Louis, 1904, p. 528.

to find new ways of testing adapted to these cases.

The writer presents herewith a series of methods developed by him as substitutes for full-load heat tests; they are all based on the assumption that the short-circuit test offers the data to predetermine in a sufficiently accurate way the regulation of an alternator, and also its normal field current and flux.

Referring to Fig. 1 and Fig. 2:

A. Calculated armature reaction in terms of the field current.
L. Induction drop, assumed to be constant for all power factors.
R. Resistance drop.
V. Terminal voltage.
E. Induced voltage.

FIG. 3

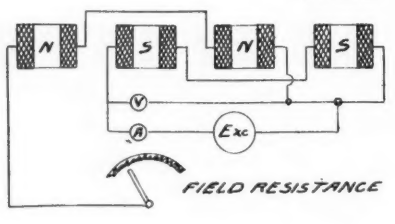


FIG 4a FIG 4b

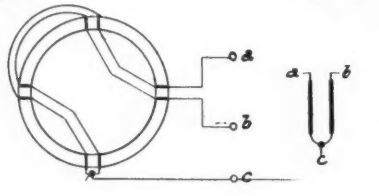
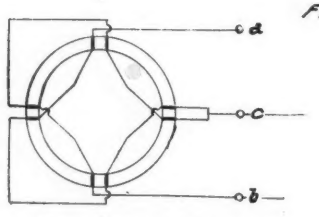


FIG 5



F. Field excitation to generate E.
F a. Actual field excitation cos ϕ — power factor.

Under normal running conditions the temperature rise in the field coils is caused by the field current F a. Barring from consideration the increased iron loss in the armature teeth, caused by a distortion of the main flux by the transverse ampere turns, we may say that the iron loss under normal running conditions equals the loss produced by the flux excited by F amperes in the field coils. Now with most of the methods enumerated hereinafter to obtain normal losses in the stator copper, there will be no armature reaction involving an excitation with F a amperes to obtain a flux corresponding to only F amperes on the no-load saturation curve.

Connection of the Field Coils—To overcome this difficulty the author devised the following disposition for the field coils, Fig. 3.

Field coils of the same polarity are connected in series. Two sets of field coils are obtained thereby. Send through one set, *f. i. s. s.*, the normal field current F a, through the other set, 2 F — F a amperes. The average excitation corresponds to $(F\ a + 2\ F - F\ a) : 2 = F$ amperes, producing the voltage E. The temperature rise is to be taken on the coils traversed by F a amperes.

Now it is a question whether the complication of the field connections is justified by the results obtained. The author believes that the temperature rise can be gotten with almost as great accuracy by not changing the field connections, by sending F amperes through the coils and multiplying the observed temperature rise by $\left(\frac{F\ a}{F}\right)$.

Armature Coil Connections—The principle of the tests to be described, consists in bringing current into the armature winding at such points that no induced electromotive force has to be overcome. This suggests the use of either direct or alternating currents to obtain the normal heating in the stator winding.

Three kinds of windings are to be considered: the first is represented in Fig. 4A, a single-phase winding; every coil consists of turns of insulated parallel conductors, the ends of which are separately connected to the ends of parallel conductors of other coils.

It is a question whether such connection has ever been made, on account of the high cost of winding. However, its application to the first machine of a new size is justifiable, provided such machine is of a large capacity, and of a small number of armature coils. In case of a small number of armature coils the conductors have to be subdivided in order to reduce the eddy current in the copper. Its application enables us to make a heat test equivalent to a full-load test, simply by supplying an amount of energy equal to the full-load copper losses in the armature winding. The full-load current, either direct or alternating, enters the winding at the terminal a and leaves it at b. Now, since in each coil the direction of the current in one conductor is opposed to that in the other, the resultant magnetizing effect of the armature is nil. The fields being excited, the voltage can be measured between a or b and c. Diagrammatically, the connection is represented by Fig. 4B, which, suggesting a U, will be hereinafter referred to as the U-connection.

The next winding to be considered is the double-layer winding. Every double-layer winding can be transformed into a two-layer circuit winding (Fig. 5, circuits a—c and b—c) by opening one connection per phase. The current enters at a and leaves at b. The voltage is measured between a or b and c. Each slot will be found to have two equal volumes of current going in opposite directions. The magnetizing action of the current is nil, and this case thus is similar to that of Fig. 4A. For this reason the connection may be referred to also as the U-connection. Whereas on the one winding (Fig. 4A) the voltage applied on the terminals a and b is about the same for direct as for alternating current on the other (Fig. 5) the direct-current voltage differs from the alternating-current voltage. We readily see that the resultant self-induced flux practically is zero in the slots; but it has its full value on the end connections (Fig. 5) so that the alternating-current voltage must be greater than the direct-current voltage for the same current intensity.

FIG 6

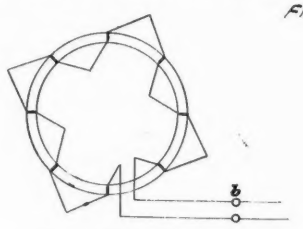


FIG. 7A FIG. 7B

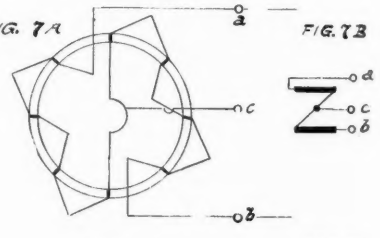
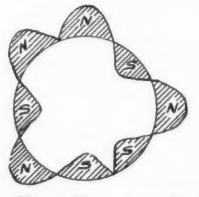
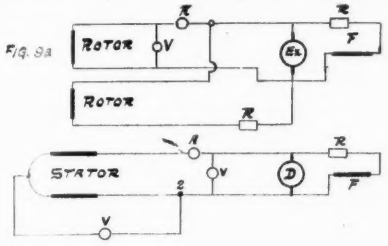


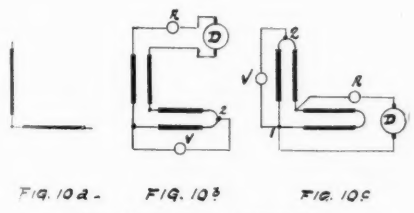
FIG 8



The third winding, a single-layer winding with turns of single conductors, is represented in Fig. 6. By loosening one connection per phase, this winding can be transformed into one shown in Fig. 7. The current enters the winding at a and leaves it at b. The voltage can be measured between either a or b and c. Dia-

grammatically, the connection is represented by Fig. 7B, and will be referred to as the Z-connection. It is immaterial whether direct or alternating current is employed; any current traversing the Z-connection produces a field shown in Fig. 8. Now, in the case of the direct current, the armature field is stationary with reference to the stator iron and causes an alternate weakening and strengthening of the revolving field poles. These fluctuations generate alternating electromotive forces in the field coils and they might cause a breakdown of the field-coil insulation. The armature flux, stationary with respect to the armature iron, alternately faces a pole face and an interpolar space; that is, two media of different magnetic conductivity. One consequence is a fluctuation of the armature flux, and a generation of alternating currents of double the frequency or rotation, short-circuited on the commutator of the current-supplying dynamo. A second consequence is a fluctuation in the driving torque of the revolving field, which sets up the vibrations in the whole structure. A third consequence is the generation of rather large eddy currents in the whole magnetic circuit, which increase the temperature rise above that of the alternator operating under normal conditions.





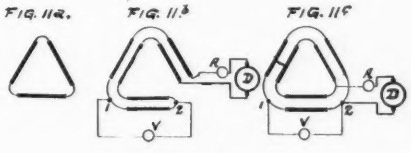
HEAT TESTS ON ALTERNATORS.

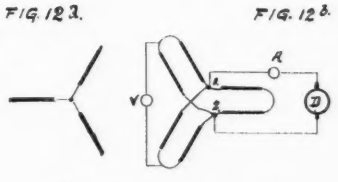
The originator of this test, Mr. R. Goldschmidt,[1] maintains, however, that the method has been tried with success on the testing floor of Messrs. Kolben & Company, Prague, Bohemia.

[1] See E. L. T. Heft 34, August 22, '01.

Entirely different phenomena are obtained by the use (in the Z-connection) of alternating currents of the frequency of rotation. The flux represented in Fig. 8 fluctuates in time-phase with the rotation of the rotor field and causes a weakening of one-half of the rotor field and a strengthening of the other half. By sending through the first half more excitation current than through the second half, it is possible absolutely to correct the unbalanced field.

A polyphase armature, the phases of which are independently Z-connected, and independently supplied with currents from a polyphase source, would generate a revolving flux in strength, stationary with respect to the rotor field, weakening one-half of the latter and strengthening the other half. The field-weakening stator winding is a generator winding. The field-strengthening winding is a synchronous-motor winding. Because the ratio of resistance to the inductance of the windings is always very small, the current supplied will be in quadrature with the electromotive force of the source, and ϕ being the phase difference between the latter and





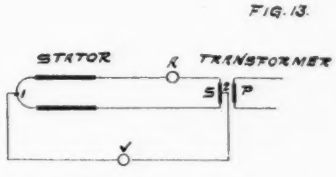
HEAT TESTS ON ALTERNATORS.

the alternator electromotive force cos $(90 - \phi)$ is the power factor of the load of the generator winding. It is seen that any load with any power factor can be secured with Z-connected armature. For $\phi = 0$, cos $(90 - \phi) = 0$, and the source of supply may be the generator itself, as will be shown farther on.

Reversing the functions of armature and field; that is, retaining the connections in Fig. 6, short-circuiting the stator winding and bucking one-half of the field coils against the other, yields the well-known Behrend split-field test. In this case the resultant field remains unbalanced for an amount equal to that necessary to generate the electromotive force, which forces the current through the stator winding. With a Z-connected armature winding, and a pressure applied on its terminals a and b, the unbalanced in the excitation current equals the current required to overcome the armature back-ampere-turns, and it remains almost constant for a constant power factor and for all voltages between a or b and c. For a power factor equal to one, the unbalance is zero.

With a split-field test the unbalanced excitation current equals the sum of the currents required to excite the unbalanced flux, and to overcome the back-ampere-turns.

The great simplicity of the split-field test for zero power-factor load, due to the absence of a foreign source of the load, is also found in what the author would term the split-armature test. Referring to Fig. 7A, it consists in paralleling the armature coils by short circuiting a b, by retaining the usual field-coil connections, and, at last, by an unequal excitation of two halves of the rotor field. As in the split-field test an unbalanced flux is required to circulate the current through the stator windings. Also, the unbalanced excitation current equals the sum of currents required to set up the unbalanced flux, and to compensate for the back-ampere-turns. It differs from the Mordey test in that the armature is split into halves. Applied on generators with a small number of poles, both split-tests have the disadvantage of producing on the generator side of the rotor field, a temperature rise greatly in excess of the rise under normal operation.



HEAT TESTS ON ALTERNATORS.

Loads with any power factor may be obtained with a split rotor field by connecting the terminals of the winding in Fig. 6 to a foreign source of current, the electromotive force of which has a definite phase relation to the electromotive force generated in the alternator under test. Any unbalanced flux can be annulled, and the unbalanced exciting current is limited to that required to make up for the back-ampere-turns.

As regards the iron losses, it is obvious that the split-armature test gives more accurate values than the split-field test, the smaller the number of poles.

TEST CONNECTIONS.

Figs. 9A and 9B show the general con-

nections of a U-connected single-phase alternator fed at equipotential points, by the direct-current dynamo D. On Fig. 9B the rotor has the normal connections to the exciter, whereas on Fig. 9A it is connected according to Fig. 3. F F are the dynamos and exciter fields; R, a rheostat; A, an ammeter, and V, a voltmeter.

Figs. 10A, 10B and 10C show the armature connections of a two-phase U-connected alternator fed by a direct-current dynamo D.

Figs. 11A, 11B and 11C show the connections of a U-connected S-wound alternator.

FIG. 14.

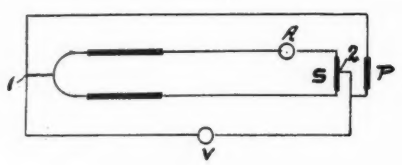


FIG. 15

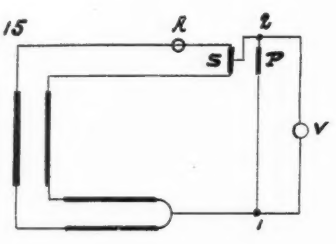
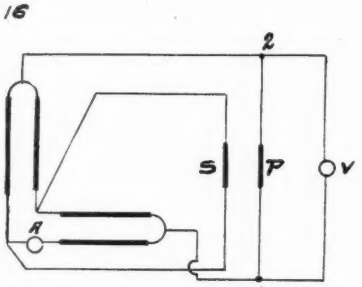


FIG. 16



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Figs. 12A, 12B, show the connections of a U-connected Y-wound alternator.

Next follow the connections to sources of alternating currents.

Fig. 13 represents the stator winding of a U-connected single-phase alternator, which derives its current from the secondary S of a transformer, the primary P of which is branched on the mains. A = an alternating-current ammeter and V an alternating-current voltmeter.

In Fig. 14, the primary derives its power from the stator windings working in parallel. It is connected to the points 1 and 2, the latter being a tap in the middle of the secondary S. The magnitude of the current in one leg on the U-winding then is different from that in the other, and the temperature rise should be observed on the side traversed by the larger current, the side indicated by the insertion of the ammeter A.

Figs. 15 and 16 show the same method of self-loading applied to a two-phase winding.

Fig. 17 illustrates the self-loading method applied to a single-phase Z-connected winding. The load necessarily is of zero power-factor, unless primary resistances are inserted in circuit.

Fig. 18 is the Behrend split-field test at zero power-factor, with its simple connections. The unbalanced pull can be annulled by inserting in the winding circuit the secondary of a transformer, the primary of which is branched on terminals 1 and 2.

Fig. 19 shows the Mordey split-armature test as modified by the writer.

Concluding remarks: The different connections for a heat-test treated above can be divided into three classes:

1. The test connections whereby no armature reaction is produced, represented

FIG. 17

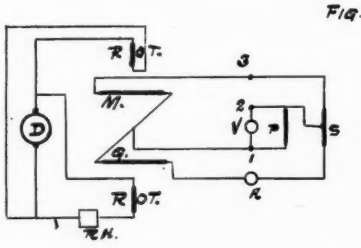
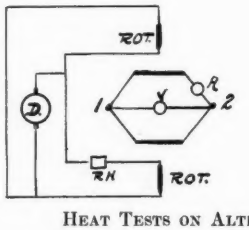


FIG. 18



HEAT TESTS ON ALTERNATORS.

by the U-connection. Full-load heat-tests can be closely imitated on machines of any number of poles, having the double-layer or parallel winding.

2. The split-field and split-armature test connections for machines with a large number of poles and any kind of winding, whereby no foreign source of current is required, thus producing an unbalanced pull as explained above.

3. The split-field and the split-armature test connections on machines with a rather large number of poles, whereby a foreign source of current is required, thus annulling the unbalanced pull as explained above.

The third class is interesting in that it offers the means to obtain the regulation curve of the alternator on any power-factor, and accurately to separate the drop due to self-induction in the armature from the drop due to back-ampere-turns. It also enables us to determine and to study the variation of the armature self-induction with different positions of the armature flux relatively to the revolving fields.

Referring to Figs 20 (split-armature) and 21 (split-field), which are the test connections spoken of above, the voltage across the secondary S is always equal and opposite to the impedance voltage of the stator winding.

It may be in any phase relation to the generated voltage, depending upon the

FIG. 19

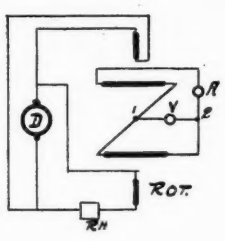


FIG. 20

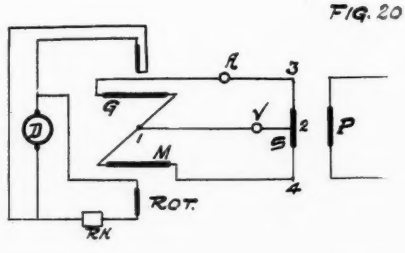
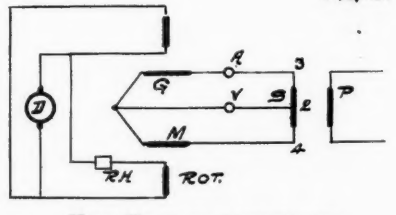


FIG. 21



HEAT TESTS ON ALTERNATORS.

phase difference between the generated voltage and the voltage impressed on the primary of the feeding transformer.

The variation of armature self-induction (equal to the secondary voltage) with the position of the armature flux can thus be studied by keeping the current constant, and varying the phase angles between the alternator and the transformer voltage.

The voltage measured between 1 and 2 always equals the voltage induced in both the generator and motor winding.

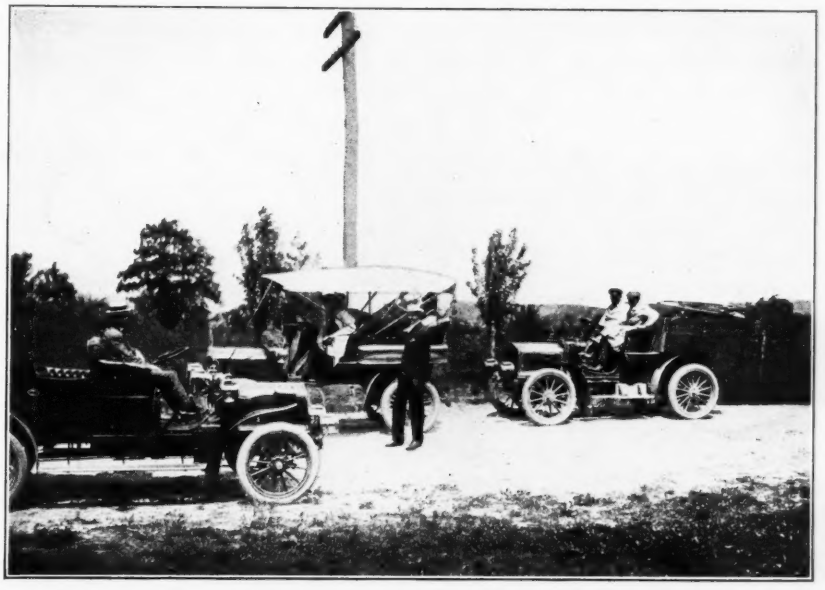
G, being the generator side, the voltage across (1—3) is the generator terminal

voltage and that across (1—4) the motor terminal voltage, (1—3) being smaller than (1—4). Whenever the fields are balanced, the regulation curve is obtained by plotting the curve representing the voltage (1—3) as a function of the generator field-current.

The author does not believe it necessary to explain in detail how the test connections for polyphase alternators are made. It is sufficient to say that a polyphase source has to feed the stator winding.

Snapshots of Edison on a Prospecting Tour.

It is reported that Thomas A. Edison has been successful in locating some important cobalt deposits in North Carolina, and that his prospectors, having reported favorably to him, Mr. Edison decided to make a trip to that part of the country to investigate conditions for himself. On May 18 Mr. Edison, accompanied by his son Charles, a Mr. Miller and two laboratory experts, left the laboratory at Orange, N. J., and started on a tour in two White steam touring cars. Mr. Edison made the entire trip in these two cars, going by way of Washington and the Shenandoah valley. He carried along a complete camping and laboratory outfit. These trips are the only vacation that Mr. Edison allows himself, and it is said that the way in which he can rough it would be a revelation to many a younger man of the present time. The views shown herewith were made en route. Invariably after lunch Mr. Edison has one of his cots taken from the machine and set up along the roadside, when he will take a short nap before proceeding on his way.



THE EDISON PARTY ON A PROSPECTING TOUR.

[Copyright, 1906, Press Photo Company, New York.]

SNAPSHOTS OF THOMAS A. EDISON AND PARTY, EN ROUTE TO NORTH CAROLINA.

Parallel Running of Alternate-Current Generators.

The *Bulletin des Séances de la Société Française de Physique* for the second quarter of last year contains an interesting article by M. Boucherot on the general principles which enter into the design and construction of alternating-current generators.

After a brief description of the present methods of construction, the author passes on to consider, first, the wave-form; secondly, the regulation; thirdly, parallel running; and finally, methods of compounding.

The most important part of the article is that devoted to the question of parallel running, and, although the mathematical treatment is not very clearly explained, the conclusions arrived at are interesting.

The question is considered under two headings. In each the subject of enquiry is the influence of the flywheel, or the flywheel effect of the rotating parts, on the oscillations about a state of uniform angular velocity; but under the first heading the oscillations are caused by the variations of turning effort of the prime mover during a single revolution, and under the second heading the oscillations are

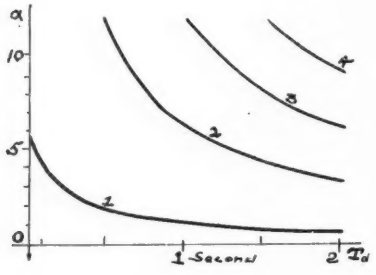


FIG. 1.

produced by the action of the engine governor.

In dealing with the first of these there are two quantities which are of prime importance in the calculations, *viz.*, the energy stored in the rotating parts, W ($= \frac{1}{2}$ J Ω^2), and the elastic couple or restoring force, C_s, which is defined as the couple which tends to restore the rotating parts to phase coincidence with the network to which the armature is connected, when the deviation is one radian. Then it is shown that the natural period of the system is $2\pi\sqrt{J/C_s}$, and the restoring force $C_s = C_n pk$, where C_n is the full-load torque, p the number of pairs of poles and k the ratio of the short-circuit current to the normal current.

Next, the analysis of the turning moment is given for single-cylinder and for multiple-cylinder engines as follows:

	Order of Harmonic.	Half Load.	Full Load.
Single cylinder...	1	0.12	0.14
" "	2	0.9	0.9
" "	3	0.12	0.11
" "	4	0.4	0.11
Multiple cylinder.	1	0.1	0.1
" "	2	0.5	0.2
" "	3	0.35	0.15
" "	4	0.4	0.4

the mean constant turning moment being reckoned as unity.

Each harmonic produces its own oscillation in the rotating system, the amplitude of which is proportional to the value of the harmonic multiplied by $\frac{1/2\, n^2}{W - W_n}$

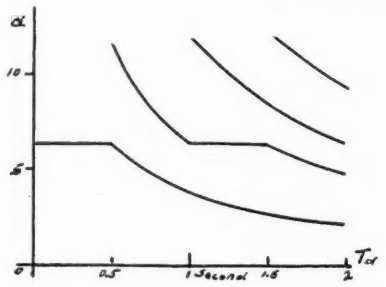


FIG. 2.

where n is the order of the harmonic and $W_n = C_s/2n^2$. If the total flywheel effect happens to be such that $W = W_n$, resonance will occur, and this expression will enable the designer to proportion the rotating parts so as to avoid serious trouble.

More interesting is that part of the article devoted to the effect of the engine governor on parallel running and hunting. The subject is confessedly a difficult one, and at present there is no accepted theory. The suggestion put forward by the author is somewhat compressed and difficult to follow; and, even so, only the chief points of the argument can be mentioned here.

The generating set with its governor is treated as being composed of two interdependent oscillating systems, each with its own natural period and its own coefficient of damping. In addition to these four quantities, two others are of great importance, *viz.*, K, the percentage variation of speed between no load and full load, and T_d the time lag of the governor. The latter quantity is defined as the time which elapses between the governor reaching its extreme position and the turning moment of the engine taking up its corresponding value. This time lag is greater in compound and triple expansion than in simple engines, due to the passage of the steam through the cylinders.

Considering, first, the case of a generating set connected to an external network assumed to be of infinite capacity, it is shown that the periodicity of the oscillation is given by the equation

$$\tan(a.T_d) = 1/2\, m\,(a_r/a - a/a_r),$$

where $2\pi/a$ is the period of the oscillations produced, $2\pi/a_r$ is the natural period of the governor, and m is the ratio of the actual damping of the governor to the smallest value of the same coefficient which makes the governor dead beat.

This equation of a in terms of T_d represents a series of curves, some of which give rise to negative values. The positive values corresponding to $m = 1$ and $a_r = 6.32$ are shown in Fig. 1. Of these curves only the lowest one represents oscillations which are not evanescent.

For this case the conclusion is reached that for satisfactory running the percentage variation of speed K must not be too small, and the flywheel effect must be designed in proportion to the time lag of the governor.

Passing to the case where two sets are working in parallel, the equation giving the frequency of the oscillations is similar to the above, provided the damping in the generators is small. In this case, however, the curves which give positive values of a are quite different, being as shown in Fig. 2. The straight line portions correspond to $a = a_a$, where $2\pi/a_a$ is the natural period of the alternator.

Now the rate of subsidence of any oscillation contains a term $(1 - a/a_a)$, and

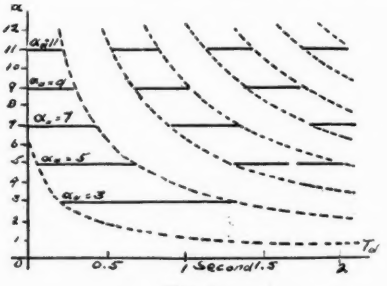


FIG. 3.

it is consequently clear that it would be unsafe to allow any value of T_d between 0 and 0.5, or between 1 and 1.5, as shown in the figure. If, however, the damping of the governor is much greater than the critical dead-beat value, satisfactory working may be possible.

A point of great interest is brought out in this connection, *viz.*, the influence of the flywheel effect. The straight portions of the curves in Fig. 2 depend upon the natural period of the alternator, which in turn depends upon the flywheel. The heavier the flywheel the less the value of a_a, and consequently the longer the straight portion of the curve as shown in Fig. 3. In other words, the greater the flywheel effect the greater will be the range of T_d for which satisfactory working is difficult. From this it would appear that it is quite possible to provide too heavy a flywheel.

The article concludes with a brief reference to the various methods of compounding alternators.—*Nature* (*London*), *April* 5.

ON A METHOD OF OBTAINING CONTINUOUS CURRENTS FROM A MAGNETIC DETECTOR OF THE SELF-RESTORING TYPE.[1]

BY L. H. WALTER, M.A.

Magnetic detectors of electric waves can, for the purpose of considering their action, roughly be divided into two classes according as the magnetic mass or core to be acted upon by the electric oscillations set up in the receiving conductor upon the arrival of waves is situated outside the influence of the magnetizing field at the time when such oscillations are acting, or is all the time in the magnetic field. In the first case, the energy available as a result of the action of the oscillations is limited to that represented by the remanent magnetism in the core, while in the second case it can be derived in part, though not wholly, from the external field.

Detectors belonging to the first class have been designed which are capable of giving unidirectional currents—practically continuously, as in the case of Fleming's quantitative detector,[2] or intermittently, as unidirectional impulses, in Marconi's more recent relay operating detector. Although no details have been published relating to the latter, a cursory inspection of the instrument exhibited at the Royal Institution in 1905 showed it to belong to this class.

Detectors of the second class, in which the magnetic mass is generally either taken through a slowly performed complete cycle of magnetism or else subjected to continuous reversals in a field of constant strength—exemplified respectively in Marconi's cyclic flux and moving band forms of detectors—present other advantages, the chief among which are automatic action and the derivation of part of the energy from the external field. No method of obtaining a continuous current from such detectors has, however, hitherto been devised, such as could be used for rapid recording work, although Tissot has described an arrangement of Marconi's cyclic flux detector by which indications were received on a ballistic galvanometer.[3] For this reason the use of these self-restoring detectors has up to the present been limited to telephonic reception, the alternating impulses produced as a result of the action of oscillations, prohibiting the employment of a relay or recording instrument. This drawback was pointed out by Marconi in his 1905 Royal Institution lecture.

In view of the above it was considered that a description of a method by which the author has succeeded in obtaining continuous unidirectional currents from a detector of this type might prove of some interest.

The method was arrived at as a result of experiments in connection with an instrument previously described,[1] to determine the cause of the increase of hysteresis loss as a result of the action of oscillations. It was found that the increase is due to a great extent, if not entirely, to the increase of induction produced, to which increased induction a largely augmented hysteresis loss corresponds at the field strength employed. Working on this basis, it was thought that such an increase of induction might serve as a means of furnishing continuous unidirectional currents, by generating a unidirectional (commuted) electromotive force, *i. e.*, by making conductors cut the lines of force in a magnetic field, and causing the oscillations to act upon a magnetic mass undergoing reversals of magnetism in the magnetic field of the generator, whereby the electromotive force generated should be augmented; a second, equal electromotive force being opposed to the first so that normally there is no external potential difference. In such a case a continuous unidirectional current should be obtainable during the time that the oscillations are acting upon the magnetic mass.

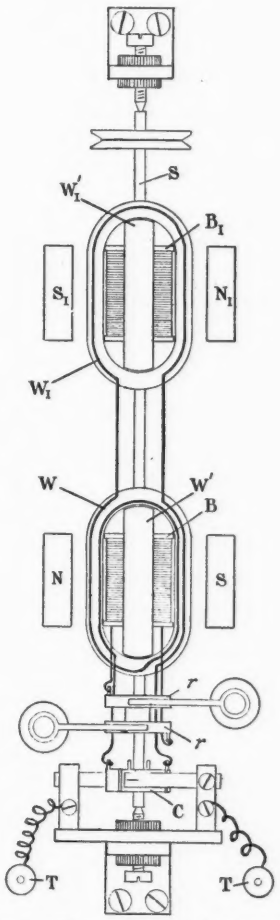


FIG. 1.—EXPERIMENTAL APPARATUS.

An experimental apparatus was accordingly made, a diagrammatic plan of which is given in Fig. 1. Two ebonite bobbins BB_1, mounted on the same spindle, are rotated in the field of two horseshoe permanent magnets NS, N_1S_1, these bobbins being wound, in a similar manner to those illustrated in connection with the pivoted bobbin detector previously referred to, with some feet of steel wire of suitable resistance. A winding of two coils W,W′, at right angles to one another, of a hundred turns, is placed on each bobbin, at right angles to the plane of the steel wire winding, as in a drum armature, corresponding coils, *i. e.*, W and W_1, W′ and W'_1, being connected in such a way that the electromotive forces generated are equal and opposite. The ends of the windings are connected to the segments of a four-part commutator C. (For the sake of clearness only one pair of corresponding windings, of one turn each, is shown connected in Fig. 1.) The steel wire windings of the two bobbins are exactly alike, the ends of one winding being insulated, while those of the other are connected to a pair of slip-rings *rr*, and brushes, by means of which the oscillations can be passed through the winding.

On testing this apparatus in the normal condition, with the armature driven by a small electric motor, and no oscillations acting, there was no potential difference at the brushes, the zero of a sensitive Ayrton-Mather galvanometer connected to the terminals TT remaining undisturbed. On waves arriving a steady deflection on the galvanometer was obtained, in a direction corresponding to an increase of electromotive force generated by the armature (bobbin) acted upon by the oscillations. On the oscillations ceasing the galvanometer deflection returned to zero. The effect naturally was very small in the first experiments, but it has been found that by suitable designing the magnetic winding and proportioning the turns in the armature winding a quite considerable sensibility is obtained, and this is continually being improved upon. The usual speed employed is about five to eight revolutions per second; higher speeds have been tried

[1] A paper read before the Royal Society, April 5, 1906. Communicated by Professor Ewing, F.R.S.

[2] "Roy. Soc. Proc.," vol. 71, p. 398, 1903.

[3] "Comptes Rendus," vol. 136, p. 361, 1903.

[1] Walter and Ewing, "Roy. Soc. Proc.," vol. 73, p. 120, 1904.

and give a larger effect, but the zero is not so steady.

The model illustrated is not adapted to give the best results, this form having been chosen solely for convenience in construction. A considerable length of the winding on the armature is "dead" wire, and hence in a new model being constructed the armatures resemble small Gramme ring structures, in which the wire is more effectively utilized.

The results obtained with the first form of the apparatus led to the idea that the magnetic mass might be located elsewhere in the magnetic circuit of M, such as at

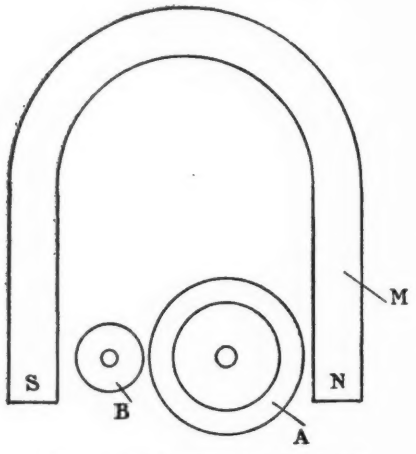


FIG. 2.—EXPERIMENTAL APPARATUS.

B in Fig. 2, undergoing slow continuous reversals at the most favorable speed, and an ordinary ring armature A be used, which latter could then be run at a much higher speed so that a proportionately greater external potential difference as a result of oscillations acting could be anticipated, two identical generators opposed to one another of course being employed as in the previous method. The few experiments made in this direction have, however, not given good results up to the present, but this is considered to be due rather to the experimental apparatus employed than to the inapplicability of the method.

Since in many cases it may be desirable to receive signals or indications simultaneously by means of a telephone as well as recording them, a telephonic receiver may be connected so as to take off the current produced as a result of such signals, at some point before it is commuted into unidirectional current, as the alternating current is better adapted for actuating the telephone. When a relay alone has to be actuated, however, it may be advantageous to so arrange matters that the generated electromotive forces do not exactly balance, and a small initial current, insufficient to actuate the relay, passes all the time through it. By this means the impulse resulting from the action of oscillations has only to supply little more than the current required to effect the actual movement of the relay tongue or coil, the steady current always passing being sufficient to almost start it from its position of rest. The change can be rapidly effected by a very slight shift of the brushes.

While the author's method of passing the oscillations directly through the magnetic winding leads to a very simple mechanical construction, there is nothing to prevent the older, more general method, being made use of, in which they are passed through a separate copper wire winding on the outside of the magnetic core (codirectional oscillations). Since this paper was written the author has seen a proof of a paper giving the results of recent experiments by J. Russell,[1] on the effect of codirectional and of transverse electric oscillations on the magnetism of sheet iron. These results tend to show, if applied without discrimination, that the iron at the low field employed is more sensitive to the codirectional oscillations; but the experimental conditions as regards the transverse oscillations, which latter are produced in a solid mass of metal, and hence are nearly entirely dissipated in the form of eddy currents, are so entirely different from the circular magnetization obtained by the author's method, in which the value of the magnetization at the surface of the magnetic wire carrying the oscillations varies inversely as the radius of the wire, that a comparison can not be made. A combination of the two methods appears to offer additional advantages, but has not yet been tried.

[1] "Roy. Soc. Edinburgh Proc.," vol. 26, No. 1, 1905-6.

Some High-Pressure Steam Pipe Details.

A few years back, says Mr. James Acton Miller, there were no fittings of any kind that could be utilized for any pipes for making deflections in a line of pipe, and comparatively young men can remember when everything of that kind was made on the spot. In fact, this was the case up to within a few years, and in some places to-day wrought bends have to be largely depended upon for elbows and other uses in piping. It is also a well-known fact that there were no appliances in the earlier days for making pipe bends on the job. The piper had to depend largely upon his own strength for getting the line of pipe into position, and this brings out the fact that a line that was larger than two inches in diameter was an exception. Up to within twenty-five years ago anything larger than this was rarely used. To-day thirty-inch wrought-iron pipe is common. At those earlier times referred to the necessity was ever present for making bends in the pipe to be used; in fact, nothing less could be done, whereas now if even a half-inch elbow is lacking when the job comes to that point the helper is sent to the shop to get it, often consuming hours of valuable time in doing this, when the old-time piper would simply have brought his knee into requisition, bent the pipe around that ever-present former, and placed it in position before the helper would have gone a square toward the shop for supplying the elbow now considered indispensable. This was the case with all sizes of pipes used at this time. Bends were made preferably to using, or trying to use, anything else, and a virtue was thus made of necessity. It was a long while before fittings were generally adopted, even after they became a common article of manufacture. It was thought that work could be done better without them, as the pipe was then made to stand bending. But when the enormous demand for pipe sprang up, and the use of butt weld and steel pipe crept in, it soon became next to impossible to bend pipe at all without the best of appliances, and doing much bending on the job was not to be thought of. The necessity for the use of wrought bends has again come to the front within the last few years, especially in the larger sizes, but for an entirely different reason. Steam pressures for various uses have increased so rapidly, to keep pace with high-pressure business methods, that pipe bends are looked upon as a positive necessity in a great many places. In point of fact, however, properly made wrought bends can be used in almost any position where a line of pipe is to be deflected, and at a much less cost than elbows or anything of a similar nature, provided there is room to get the bend in position. Where there is no necessity to use an elbow and fittings because of the structural details of the plant, a considerable actual cash outlay may be saved. In addition to this, the friction in the passing of steam around the elbow, attended by condensation and wet steam, will cause a considerable loss, in addition to the cash loss above referred to. In other words, if the line of piping with the long-radius bend carries steam produced by a coal bill of, say, $20 a day, every elbow will put a tax on this amount of one per cent at least in deterioration of the steam and loss of its effective pressure. The loss is still more pronounced with high-pressure

steam, as the above figure is based on pressure as formerly used (about eighty-five pounds). When it comes to steam rushing through for the present high-speed engine with 250 pounds pressure, the eddy formed by the elbow is of the most damaging character. No data are to be had showing the actual loss occasioned by the use of elbows with the latter pressure, although it is reasonable to suppose that it would be two or three times greater than with the lower pressure. Proper appreciation of this would revolutionize all piping work, make the use of wrought bends universal, and restrict the use of elbows to only such cases where they were absolutely necessary. It would save large sums of money, counting the first cost only, as it is an indisputable fact that every elbow used costs two or three times as much as a bend would cost, providing it were possible to use a bend in the position that the elbow takes. This statement, of course, has reference more especially to the larger sizes of piping, but even in hot-water heating systems, sprinkler jobs and small pipe work frequent savings can be effected by the use of wrought bends instead of elbows, increasing the efficiency and circulation of the hot water or other system. And this is also true in conveying liquids generally. Some persons advertise that they make very close-radius bends, but it is a mistake to do this in a general way. With close-radius work, pipes will frequently break. Any one can make bends to a very short radius if absolutely necessary, and if they go about it right; yet no one can make them as cheaply as they can make those with a reasonably large radius.—*Cassier's Magazine.*

The Utilization of Scandinavian Waterfalls.

The opinion, says *Nature* (London), has been frequently expressed that Scandinavia, with its huge waterfalls, will, before long, be one of the most suitable places for large commercial works. Indeed, it is claimed that with the future developments of electrochemical technology the greater part of the world's supply of soda, chlorates, nitrates, calcium chloride and iron will be produced in the northern peninsula; hence it is easy to understand the action of the Swedish and Norwegian governments in protecting the falls against foreign capitalists. Sweden has passed a law that the use of the falls is reserved to the state, while a bill is before the Norwegian Storthing, in which it is prescribed that at least one-half of the capital laid out on the falls shall be Norwegian money, and the direction of the works be in the hands of Norwegians who are living in the land.

LONG FLAME ARC LAMPS.[1]

BY LEONARD ANDREWS.

Until comparatively recently all tests and experiments made with arc lamps appeared to show conclusively that to obtain the highest efficiency the length of the arc should not exceed three millimetres or four millimetres. Mrs. Ayrton[2] shows that "almost the whole of the increased power that has to be supplied to the arc when it is lengthened is swallowed up by the mist and is practically wasted." The following table of comparative efficiencies appears to show, however, that, while increasing the length of the arc beyond three millimetres or four millimetres does tend to reduce the efficiency of arc lamps with coaxially arranged pure carbons, this rule does not apply to many of the long flame arc lamps having inclined downward feeding carbons which have now begun to be very generally used.

Taking the mean of the results given by different authorities, and reducing them all to a common basis by making the necessary corrections for globes and different standards of illumination, it appears that the relative efficiencies expressed in mean hemispherical British candle-power of the different types of lamps are approximately as follows:

TABLE II.

	C.-P. per Amp.	C.-P. per Watt.
Ordinary open arc....	82	1.54
Enclosed arc	55	0.77
Carbone H. T. arc....	200	2.24
Chemical carbon arc.	259	5.80

While it is the usual and, for some purposes, more useful practice to specify the efficiency of an arc lamp in candle-power per watt, it is thought that the candle-power per ampere may also be a useful figure. It will be remembered that in the discussion that took place a few years ago on the question of changing the pressure of supply from 100 to 200 volts, a favorite argument used by those opposed to the change was that the majority of tradesmen using arc lamps required two lamps only, and that, should the pressure be doubled, these consumers would be forced either to alter their wiring and install four lamps where they only required two, or to absorb over

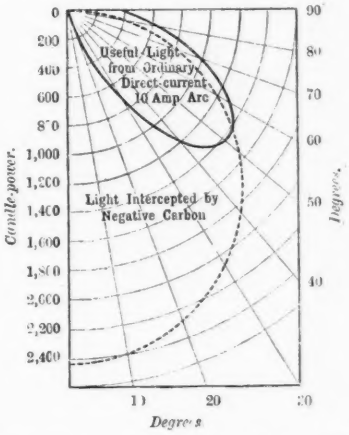


FIG. 1.—LIGHT EMISSION FROM ARC LAMP.

fifty per cent of the total energy in useless resistance. The introduction of the high-voltage enclosed arc lamp, however, overcame this difficulty, and in spite of its low efficiency per watt its use has now become very general. In considering improvements in arc lamps it is necessary, therefore, to bear in mind that, for many purposes, low-voltage lamps can not be used to the greatest advantage.

TABLE I.

Type.	Amps.	Volts.	Watts.	Mean Hemispherical C.-P.	Authority.
Ordinary open arc.	..*a*	..*a*	440	400*b*	Dr. Wedding
Ditto.	..*a*	..*a*	476	633*c*	Westminster Elec. Testing Laboratory
Ditto	10	45	450	830	Calc. from Fig. 1
Enclosed arc.	6.6	71	459	360*d*	U.S.A. Photometric committee
Ditto	..*a*	..*a*	485	338	West. E. T. Lab.
Carbone H. T. arc.	9.3	89.1	820	2,080	Dr. Wedding
Chem. carbon arc.	..*a*	..*a*	382	1,325*c*	West. E. T. Lab.
Ditto	10	46	460	2,750	Excello pamphlet

a. Not specified. *b.* Mean spherical candle-power. *c.* Tested with opalescent globe. *d.* Tested with opalescent inner and clear outer globes.

Returning to the question of long arcs versus short arcs, it is an interesting fact that all the very marked improvements that have been made in arc lighting during recent years have been effected by the use of arcs of from ten millimetres to fifteen millimetres in length, and investigation shows that the great improvement in efficiency is directly or indirectly due to this increased length.

The improvements effected may be briefly summarized as follows: (*a*) the formation of the positive crater in such a position that none of the light emitted by it is obstructed by the negative carbon;

[1] Abstract of a paper read before the Institution of Electrical Engineers of Great Britain, April 26.
[2] "The Electric Arc," p. 371.

(*b*) the impregnation of the carbons with metallic salts, thereby rendering the flame highly luminous.

It is well known that the maximum illumination obtainable from a pure carbon arc lamp in any direction is proportional to the area of the positive crater visible in such direction, plus the light emitted by the red-hot portions of the carbons, the white spot on the negative and the flame or arc mist; and since the area of the crater is approximately proportional to the current and is not appreciably increased by an increase of voltage, it would appear at first sight that to expend energy on an increase of voltage must tend to decrease the efficiency. It must be remembered, however, that for all practical purposes it is not so much the actual area of the crater that determines the useful efficiency of an arc as the area visible at any angle below the arc. Trotter has shown that if none of the light from the

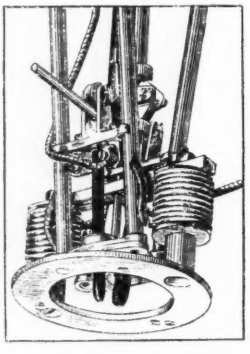


FIG. 2.—ENDS OF CARBONS AND ECONOMIZER, "CARBONE" ARC LAMP.

positive crater is intercepted, then the candle-power from this source at any angle may be represented by the radius vectors of a circle drawn to such a scale that the diameter of the circle is proportional to the candle-power measured directly facing the crater. To be able to calculate and plot the candle-power from the area, the intrinsic brilliancy of the positive crater must, however, first be determined. This has been found by three different authorities[1] to be 146, 158 and 170 candle-power, respectively, per square millimetre, and as the mean of these results is 158 candle-power per square millimetre, it appears reasonable to take this figure for calculating the candle-power of the positive crater from its area. There is, however, also to be taken into consideration the fact that the intrinsic brilliancy of the soft core portion of the crater is considerably less than that of the hard carbon portion, and probably does not exceed 100 candle-power per square millimetre.

Referring to Fig. 1, it is seen that not only is a very large proportion of the total light emitted by the positive crater intercepted by the negative carbon, but that the waste from this cause occurs in the direction in which, for many purposes, it can least be spared. It is evident, therefore, that a very large economy can be effected by causing the positive crater to form in such a position that, whatever angle it be viewed from, none of it shall be cut off by the negative carbon.

Many attempts have been made during recent years to solve this (at first sight) simple problem. Some of these attempts have been directed toward increasing the length of the arc of an ordinary arc lamp, with the idea of thereby allowing more light to escape. In some notes on Angold arc lamps published by the General Electric Company, London, it is stated "an increase of voltage lengthens the arc and decreases the shadow of the negative carbon, thus giving more light at a greater efficiency, but the practical limit is reached at forty-five volts, when the unsteadiness from flaring counterbalances the improvement in light." Mrs. Ayrton shows,[1] however, that no useful object is attained by increasing the length of an ordinary arc beyond three millimetres or four millimetres, as the light absorbed by the lengthened arc mist exceeds the additional light which escapes unintercepted by the negative carbon.

Various other attempts have been made to get an unobstructed positive crater by the use of inclined carbons, but all these experiments appear to have been carried out with voltages of from forty to forty-five volts across the arc, and at these pressures the crater forms on the side of the positive carbon between it and the negative instead of at the tips, and consequently, at pressures of less than sixty or seventy volts, more light is intercepted by the negative carbon with inclined carbons than with carbons arranged in the ordinary way. Carbone appears to have been the first to suggest that the solution of the difficulty was the use of inclined carbons combined with a voltage of from eighty to ninety volts across the arc. While the mere appreciation of the advantage of high voltage with inclined carbons constitutes a marked advance in arc lighting, further invention was necessary to render the system practicable. Carbone also discovered a method of controlling the long arc without flickering, and succeeded in obtaining a form or shape of flame which reduces to a minimum the absorption of the light from the crater by the arc mist.

Fig. 2 shows the ends of carbons and the economizer of a "Carbone" arc lamp. The arrangement of these appears to be, at first sight, precisely similar to that of all other flame arc lamps. The essential difference, however, lies in the magnetic control of the arc. Any attempt to repel the arc to the tips of the carbons by means of a moderately strong concentrated magnetic field produces an effect somewhat similar to that of a blowpipe, tending to blow the arc into a bluntly pointed flame, extremely difficult to keep steady and of a shape that increases the length of the arc mist to be traversed by the light emitted by the positive carbon.

The Carbone method of controlling the position of the arc is shown in Fig. 3. This consists of a closed iron magnetic circuit, the only field affecting the arc being that due to magnetic leakage from this closed circuit. The chief leakage will obviously be from the ends of the cores carrying the exciting solenoids.

In Fig. 4 the areas of the craters visible

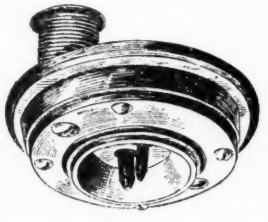


FIG. 3.—METHOD OF CONTROLLING POSITION OF ARC.

directly below the arc with different voltages are plotted with rectangular coordinates, and a curve is added showing the efficiency in candle-power per watt, assuming that the candle-power is directly proportional to the area of the crater. It will be noted that this curve has a very different characteristic to the corresponding curve given by Mrs. Ayrton[1] for coaxially arranged carbons, which latter is reproduced in Fig. 5. This reaches a maximum at about forty-two volts and then steadily falls, whereas the "Carbone" efficiency curve continues to show a marked improvement up to eighty volts.

It has so far been assumed that the candle-power emitted by the positive crater is proportional to the area of such crater, and that no appreciable proportion of the light emitted is intercepted by the arc mist.

To ascertain how far this assumption

[1] Dr. J. A. Fleming, "The Photometry of Electric Lamps," *Journal* of Institution of Electrical Engineers, vol. xxxii, p. 137.

[1] "The Electric Arc," p. 293.

[1] "The Electric Arc," p. 382.

is justified, we may compare with the polar curve constructed by Dr. Wedding showing the candle-power measured at a number of different angles, the polar curve constructed by multiplying the area of the craters in square millimetres by the intrinsic brilliancy in candle-power and by the cosine of the angle.

The positive crater area of a 9.3-ampere

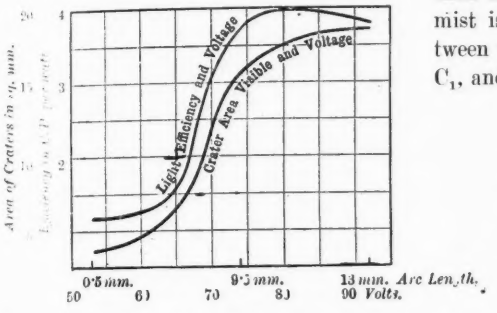


FIG. 4.—VISIBLE AREA OF CRATER AND EFFICIENCY OF CARBONE ARC.

eighty-nine-volt "Carbone" arc was found to be 17.1 square millimetres, of which three square millimetres were of soft-cored crater. The candle-power emitted by the positive crater, plus that emitted by the negative or white spot, should therefore be:

Hard carbon positive crater	14.1 sq. mm.	× 158 =	2,227.8
Soft-cored " "	3.0 "	× 100 =	300.0
Negative crater..... ...	1.5 "	× 158 =	237.0
			2,764.8

As, however, Dr. Wedding's results are given in Hefner units, it will be necessary to divide the total maximum candle-power as calculated above by 0.88, the result being a maximum candle-power in Hefner units of 3,142.

The polar curve A, B, C, Fig. 6, can now be constructed, the maximum radius vector being made proportional to the candle-power derived as stated above. It will be seen that this curve is considerably smaller than Dr. Wedding's curve plotted from the mean of actual candle-power measurements taken at a number of different angles and in different vertical planes. We have, however, to add to the candle-power derived from the area of the craters the candle-power of the flame and of the red-hot portions of the carbons. The candle-power from these sources in the "Carbone" arc is very considerable. Dr. Wedding found the mean candle-power measured in the same horizontal plane as that occupied by the craters to be approximately 900, and as practically none of this could have come from the craters, the bulk of it must have emanated from the flame and red-hot portions of the carbons.

It may be assumed that the candle-power from these sources is practically constant in all directions. We may, therefore, add to the radii of the polar curve representing the light from the craters a length proportional to the light from the flame and red-hot portions of the carbons. A third curve, A_1, B_1, C_1, may now be constructed, representing the total light emitted from all sources. It would appear then that the light intercepted by the arc mist is represented by the difference between the radius vectors of curves A_1, B_1, C_1, and Dr. Wedding's curve of actual results, always assuming, however, that the figure of 158 candle-power per square millimetre which has been taken represents the true intrinsic brilliancy of the craters. This figure is, however, probably sufficiently accurate to show that with a "Carbone" shaped flame only a small proportion of the total light is intercepted, and consequently that the high efficiency of this lamp is in a great measure chiefly due to none of the crater light being intercepted by the negative carbon.

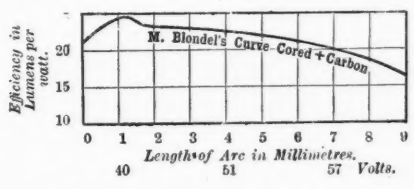


FIG. 5.—EFFICIENCY CURVE OF ARC WITH CO-AXIAL CARBON.

Turning now to the second improvement effected in arc lighting, namely, that due to the impregnation of the carbons by metallic salts, even greater radical departures from hitherto accepted principles are found. While by far the chief source of light in a pure carbon arc is the positive crater, we see from Fig. 7, which is reproduced from a ten-ampere chemical carbon arc, that the area of the crater is only about sixty-five per cent of the area of a ten-ampere pure carbon arc, the intrinsic brilliancy being also probably less even than that of the soft core of a pure carbon crater. It would appear, therefore, that of the total candle-power of 2,750 hemispherical candle-power emitted by a ten-ampere chemical carbon arc, less than 700 candle-power is emitted by the positive crater. While, therefore, the high efficiency of this type of arc is in a measure due to the formation of the craters in such a position that none of the light from the positive crater is intercepted by the negative carbon, it is evident that it is only partially due to this cause.

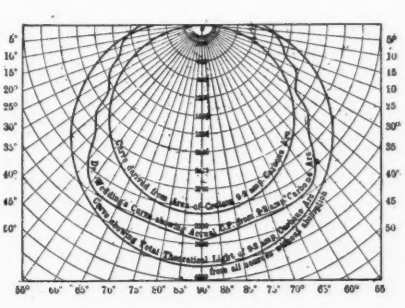


FIG. 6.—CANDLE-POWER CURVES OF CARBONE ARC.

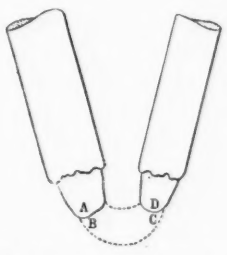


FIG. 7.—TEN-AMPERE ARC.

The crater area of a chemical carbon arc is in a great measure dependent upon the portion of the carbon that is being consumed at the time. For instance, in Fig. 7 it will be seen that the arc is burning almost entirely from the chemically impregnated core; whereas the chemical core has become hollowed out and the crater appears to be formed on the edge of the hard carbon shell. In this position the crater area is extremely small. When the shell on the side of the positive carbon nearest to the negative carbon has burnt away, the crater gradually travels round to the opposite side of the carbon. This causes considerable difference in the pressure across the arc, the total variation sometimes amounting to as much as fifteen per cent; that is to say, the voltage will increase from forty volts, when the crater is on the near side of the positive carbon, to forty-six volts when it is on the far side. It is interesting to note that, owing apparently to the lower resistance of a chemical carbon arc, the craters can be

TABLE III.

Volts Between.	Ordinary 3 mm. Arc Lamp.	"Carbone" High-Voltage Arc Lamp.	Chemical Carbon Arc Lamp.
A and B....	34 volts	36 volts	17 volts
A and C ...	....	78 "	36 "
A and D....	49 volts	88 "	46 "
B and D....	....	44 "	28 "
C and D....	9 volts	10 "	10 "

retained at the tips of the carbons with a very much lower voltage than is required for a pure carbon arc. Another noticeable difference between chemical carbon arcs and pure carbon arcs is to be found in the drop of potential across the positive crater.

Table 3 shows the drop of voltage in different ten-ampere arcs measured between the respective points indicated by letters in Fig. 8.

The bulk of the light from a chemical carbon arc emanates from the flame, and is apparently due to minute burning particles in the flame which are raised to a very high state of incandescence. It has been found that the relative intrinsic brilliancy of the flame of a chemical carbon lamp is about one-third that of the positive and negative craters. It must be remembered, however, that the area of the flame visible at any angle is many times that of the crater, and the total light emitted by the flame is consequently many times that emitted by the craters.

While the commercial use of chemically impregnated carbons has only come to the fore within the past two or three years, the idea is by no means new. Trotter, in his paper before the Institution of Electrical Engineers of Great Britain in 1892, made the following reference to the suggestion: "Several attempts have been made to improve the arc by adding volatile substances, or by introducing gas through a hollow carbon. The only good effect that can be expected is the production of a long arc, which will reduce the shadow of the lower carbon; and it is likely that the temperature of the crater will be reduced by the presence of any substance less volatile than the best carbon." It would appear from the above that the chief gain in efficiency due to the high luminosity of the flame was not then appreciated. The efficiency of a chemical carbon lamp is so very much higher than it has yet been possible to attain with any type of pure carbon arc that it might appear at first sight that the use of pure carbons would very soon cease. Unfortunately, however, the advantage from the point of view of efficiency is discounted by certain defects which render this type of lamp unsatisfactory for many purposes.

The flickering noticeable in all chemical carbon lamps can not at present be entirely overcome, though it has been greatly reduced in recent lamps. Considerable improvement has been effected during the last year or two in the composition of the carbons used for chemical carbon flame arc lamps. The large amount of calcium salts first proposed by Bremer and the non-conductive scoria caused a great irregularity in burning. The carbons are now usually of the composite type, consisting of three zones. The outer zone or envelope is composed of pure carbon, giving mechanical strength. The next contains carbon mixed with various salts, such as those of calcium and magnesium, and the inner soft centering core is made of the same materials less strongly compressed.

The poisonous fumes given off by the burning chemicals make the lamp unsuitable for use in a room not very efficiently ventilated, besides which these fumes are very apt to injure the mechanism of the lamp. The ash or residue from a chemical carbon arc is very much greater than from a pure high-voltage flame arc lamp. The author has obtained photographs of the ash from a ten-ampere chemical carbon arc and from a ten-ampere "Carbone" pure

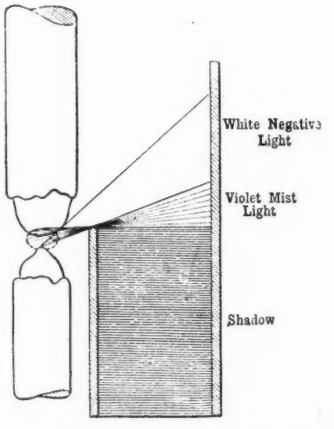


FIG. 8.—COLORED SHADOW EFFECT OF ARC.

carbon arc after two hours' burning by placing plates of clear glass in the respective globes, these being carefully removed without disturbing the ash and used as negatives. The ash from the chemical carbon lamp was many times greater than that from the pure carbon arc. The carbons are at present considerably more costly than pure carbons, and as the globes can not be entirely enclosed the life of the carbons is very short. The light is useless in positions where discrimination of colors is required.

Color—The color of an artificial light is for many purposes of even greater importance than its efficiency. Considerable difference of opinion exists as to what is the best color, and this difference will probably remain so long as it is attempted to define any one particular color as the best for all purposes. For the illumination of the outsides of public buildings, theatres, etc. (especially where these are built of stone), there is nothing more effective and more pleasing than the yellow color given by the chemical carbon arc lamp. It is also the best light for penetrating a thick yellow fog. For many other purposes, however, a pure white light is generally to be preferred. What is the exact definition of the term "white light" is somewhat difficult to express. It is certainly not the violet tinted light of the ordinary arc lamp, nor is it the distinctly green light of the incandescent gas lamp. Possibly the best definition is: "a light which makes all colors appear to be exactly the same, whether illuminated by daylight or the artificial light in question." The yellow light given by the majority of chemical carbon lamps is sometimes claimed to be similar to that of sunlight. One of the best tests of this is to examine colors, or, say, a crowd of faces illuminated by one of these lamps. It will be at once apparent that the resemblance in the effect of the two lights is extremely remote.

The nearest approach to a pure white light that has yet been attained by artificial means appears to be that of the high-pressure pure carbon arc with downward feeding inclined carbons. That it is so, however, is somewhat surprising, as it would be expected that the very long flame of the high-voltage arc would give a very violet light. The extreme whiteness of this light is referred to by Dr. Wedding in his report on the "Carbone" arc. In discussing the cause of this he says: "the spectroscope analysis shows a very wide spreading out in the violet parts of the spectrum alongside of a strong line in the yellow green. Numerous lines stand out in the violet, through which no doubt the tone of the color is called forth."

Sir W. Abney has shown that the light emitted by the positive crater of a pure carbon arc lamp is very like sunlight, but has a slight excess of orange and green rays, and a slight deficiency of blue. Notwithstanding this generally accepted fact, it is well known that the light from an ordinary arc lamp tends to make objects appear to be blue or purple, particularly when the arc is long. Mrs. Ayrton[1] attributes this blueness to the fact that a portion of the light from the crater in passing through the flame of the arc is reflected and refracted by minute particles of incandescent carbon, and as these carbon particles absorb the red and green rays, and allow the violet rays to pass, the light emitted by the flame or carbon mist is of a deep violet color. It would appear, therefore, that if just the correct quantity of this violet light could be mixed with the direct light from the crater, which, as has been shown, is deficient in violet rays, the

[1] "The Electric Arc," p. 357.

result would be an exact reproduction of sunlight. In the ordinary direct-current arc a large percentage of the crater light is intercepted by the negative carbon, whereas, owing to the very much larger area of the flame, comparatively little of the light from it is so intercepted. The resultant mixture, therefore, contains far more violet rays than are required to produce a pure white light.

The color effect of intercepting a portion of the light emitted by the positive crater may be shown by a simple experiment suggested by Mrs. Ayrton. If a plate of metal is interposed between the arc and a screen, as shown in Fig. 8, the shadow of the metal will be edged with a broad band of violet light, this being the portion of the screen illuminated by the refracted light from the carbon particles constituting the arc mist.

Now it appears reasonable to argue that the interception of some of the direct rays from the positive crater by the negative carbon of an ordinary arc lamp must have the same effect upon the total color of the light as the metal screen referred to above. The fact, therefore, that none of the crater light of the "Carbone" arc is intercepted may, at any rate partially, account for the pure whiteness of this light. It is also noticeable that the light from the flame itself is by no means so violet as that of an ordinary arc lamp. This appears to be due to the large area of the sheath of burning gases. Is it not possible that this sheath is the cause of the numerous dark lines which Dr. Wedding observed in the violet portion of the spectrum, and to which he attributes the tone of the color? Certainly the portion of the arc mist which is not sheathed by burning gases (namely, the upper portion of the hemispherically shaped flame) does emit a light which is intensely violet. This very violet light is thrown up into the mechanism between the carbons and the insulating carbon guides.

General Effect and Distribution of Light—It is interesting to note that arc lamp designers have during recent years paid very much more attention to these points. There is no doubt that for effective lighting the globe should have the appearance of being full of light. The popularity that has recently been attained by several types of enclosed arc lamps is undoubtedly in a great measure due to the use of small globes, and while the efficiency expressed in the "mean hemispherical candle-power per watt" is considerably lower than that of the large globe open-type arc, the efficiency expressed in the "satisfaction to the general public per watt" is considerably greater. The long flame arc is particularly well adapted for use with small globes, and all flame lamps, whether of the chemical-carbon type or of the high-voltage pure carbon type, always appear to give a good globeful of light. This effect is also in a great measure due to the absence of shadows resulting from the use of inclined carbons.

It must be remembered that the general public do not judge of the efficiency of any system of lighting by taking photo-

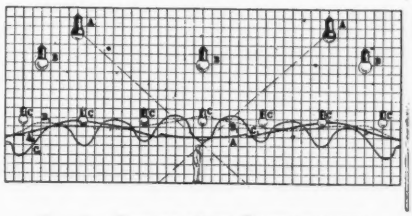


FIG. 9.—COMPARATIVE ILLUMINATION.

metric tests. It would probably be much better for the electrical industry if they did. Their usual method of judging a light is, first to look at the source of light, to satisfy themselves that there is a large area of light-giving surface, and secondly to examine the ground directly below the lamp they are judging. The engineer, however, recognizes that it is of even greater importance to know what is the minimum illumination midway between lights than it is to know the maximum illumination directly below the arc.

It is well known that at least forty per cent of the light emitted by an arc lamp is intercepted by the opalescent globe. This waste, with ordinary arc lamps, appears to be necessary, in the first place to prevent the dazzling effect which would result from an unscreened arc fixed at a position that comes within the natural angle of sight, and in the second place to give a diffused light, or the effect of a light emitted from a large surface. Dealing first with the screening effect necessary to prevent dazzling, this need not be considered if the source of light can be placed at such a height above the ground that it does not come within the natural angle of sight. It appears, in fact, that we might take a lesson from Nature. At midday, in mid-summer, when the sun is directly above our heads, and consequently not within the natural angle of sight, the light emitted by it is comparatively unscreened, and is blinding to look at, even for a moment. When the sun is setting, however, and is consequently directly within the angle of sight, such a large percentage of its light is intercepted or screened by the atmosphere that we are able to distinguish objects clearly which are in a direct line between ourselves and the sun.

Owing to the fact that with an ordinary arc the bulk of the light is emitted at angles of less than sixty degrees below the horizontal, it is necessary to place such lamps comparatively near the ground to get efficient results from them. This objection does not, however, apply to long-flame arc lamps in which the maximum light is directly below the arc. It appears, therefore, that for many purposes, such, for instance, as for lighting large buildings, where the source of light can be placed thirty feet or forty feet above the ground, it is unnecessary to use densely obscured globes. It is suggested that for this purpose long-flame arc lamps should be used, fitted with globes of which the lower half is unobscured.

Curves A_1, B_1 and C_1, Fig. 9, show respectively the illumination per square foot on the floor space of a room illuminated by 800 watt high-voltage pure-carbon long-flame arc lamps, with globes half unobscured at A, A, twenty-five feet above the ground, and with similar lamps fitted with globes, absorbing forty per cent of the light at B, B, B, twenty feet above the ground, and with 460 watt ordinary enclosed arc lamps at C, C, C, etc., ten feet above the ground. It will be seen that the mean illumination is approximately the same in each case, but that a considerable

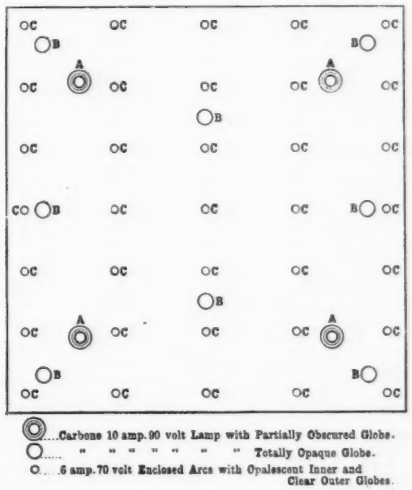

Carbone 10 amp. 90 volt Lamp with Partially Obscured Globe.
" " " " " " " Totally Opaque Globe.
6 amp. 70 volt Enclosed Arcs with Opalescent Inner and Clear Outer Globes.

FIG. 10.—ARRANGEMENT OF LAMPS.

saving of energy is effected by using unobscured flame lamps twenty-five feet above the floor level. It is also noticeable that the distribution of light is much more even with the few lamps placed high up than with the larger number of lamps nearer the floor. Fig. 10 shows the arrangement of lamps required to produce a given mean illumination over a given

floor space, the energy expended with the three systems being respectively as follows:

	Watts.
Four 800-watt unobscured high-voltage flame lamps.....	3,200
Eight 800-watt obscured high-voltage flame lamps.....	6,400
Thirty-five 460-watt enclosed arcs	16,100

It is obvious that by doubling the height of all the lamps a floor space of four times the area would be illuminated to one-fourth the brilliancy.

Alternating-Current Arcs—Alternating-current lamps are very unpopular in England on account of their very low useful efficiency. This is in a great measure due to the fact that about fifty per cent of the light is thrown up into the air, where for many purposes it is entirely wasted. This defect, however, disappears in long flame downward feeding carbon arcs, as the whole of the light emitted by both craters is thrown down. Dr. Wedding has found that the efficiency of an alternating-current lamp of this type is practically similar to that of a direct-current arc of the same type.

Another objection to alternating-current arcs is that, when connected across an alternating-current circuit of less than fifty cycles per second, the flickering is very objectionable. It appears that this difficulty may also be considerably lessened by using downward feeding carbon arcs in which both craters are visible directly below the arc. As in the ordinary coaxially arranged carbon arc only one crater is visible from any position during one entire half of each cycle, there must of necessity be a dark period between each flash of light.

Electric Signs and the Load Factor.

The most serious problem confronting the central station manager to-day is the matter of the rates at which electricity for lighting or power purposes shall be sold. None of the savings in generation or distribution now known to the fraternity can materially reduce the costs of manufacture nor eliminate the fixed expenses or current losses, but by a constant increase in the volume of desirable business, a company can reduce its average cost of current, due to the fact that the fixed expenses, either for consumption or demand, will not grow at the same rate as the output costs. It is therefore more and more evident that we must hope to follow the plan of the larger mercantile establishments in looking for future growth in large sales at relatively low prices rather than small sales at high prices.

We all realize that a perfect load-factor is our ideal, and that the better our load-factor can be made, the more closely have we approached success. So far as the lighting end of the business goes, the developments of the last few years have shown that long-hour display or advertising lighting presents the most opportunities for improving the load-factor.—*Excerpt from a paper entitled "Business Getting Methods" by F. W. Frueauff.*

MAGNETIC PROPERTIES OF ELECTROLYTIC IRON.[1]

BY C. F. BURGESS AND A. HOYT TAYLOR.

Iron which has been deposited electrolytically from an aqueous solution is not necessarily a definite product, but varies in chemical composition and physical constitution, depending upon the adjustment of the various factors which govern the deposition. High purity is a property frequently ascribed to electrolytic iron, and it is probably a fact that by no other means can iron be purified to as high a degree as is possible by the electrolytic method. It is safe to say that absolutely pure iron has never been produced either electrolytically or by any other method.

The incentive which had led to a large amount of work on the electrolytic refining of iron is the need of a material of a high degree of purity to serve as a basis for the study of iron and its alloys. Until comparatively recently electrolytic iron has, however, been something of a curiosity due to the difficulty of depositing it in anything but thin layers. Several years ago an investigation was undertaken in the applied electrochemistry laboratory of the University of Wisconsin looking to the production of electrolytic iron in large quantities, and as a result it has been demonstrated that iron may be refined at a rate and a cost comparable to that existing in electrolytic copper refining. A further investigation of the production and properties of electrolytic iron and of various alloys made from it, has been made possible by a grant from the Carnegie Institution of Washington, and while working under this grant, nearly one ton of electrolytic iron has been produced, and plates one inch in thickness and weighing seventy-five pounds have been made. In following the question of a large scale production, particular attention was not given to the matter of purity, and as a result the iron which was produced did not equal the best grades of iron obtained on the market. Marked improvement has been made recently, the following analyses, for which acknowledgment is made to Mr. Andrew A. Blair, showing something of the degree of purity obtainable.

	No. 1. Per Cent.	No. 2. Per Cent.
Sulphur..	...	0.001
Silicon.	0.013	0.003
Phosphorus	0.004	0.020
Manganese.....	....	...
Carbon	0.012	0.033
Hydrogen.....	0.072	0.083

[1] A paper presented at the twenty-third annual convention of the American Institute of Electrical Engineers, Milwaukee, Wis., May 28-31, 1906.

It may be noted that hydrogen is present in an amount greatly exceeding all the other impurities combined, and it is to the presence of this element that the characteristic properties of electrolytic iron are usually ascribed. It is well known that electrolytic iron as taken from the depositing solution is usually hard and brittle, and to such a degree that it may be crushed to a powder. Upon heating to a temperature of about 1,000 degrees centigrade and upward, it becomes soft and malleable.

The exact cause of this remarkable change of physical properties is not clearly apparent, though since some hydrogen has been observed to be given off during the heating operation, a relationship has been held to exist between the hardness of the iron and the hydrogen content. Some doubt is cast upon the existence of such relationship through the fact that similar amounts of hydrogen have been found in soft electrolytic iron which had been fused and in hard brittle iron before fusion, and the question is one calling for further investigation.

It is well known that the magnetic properties of electrolytic iron are altered to a great degree by heat treatment, and it is the purpose of an investigation now under way to establish the relationship between coercive force, permeability, hysteresis constants, etc., and the temperature at which the iron is heated. This paper is intended only as a short preliminary report on work which has been under way for some time, but which, owing to difficulties encountered in depositing and machining of the samples to be tested, has made but slow progress.

To prepare the test specimens necessary for the Rowland ring method of magnetic measurement, plates of electrolytic iron about one inch in thickness were deposited from a ferrous sulphate solution slightly acidified, containing also a small amount of ammonium sulphate. This deposition required about eight weeks. The resultant plate was ground smooth, and the ring was made from it by drilling and grinding, care being taken to prevent the metal from becoming heated. The first ring had to be rejected on account of a crack which developed in it. The first one upon which the measurements here described were made had an average radius of 4.34 circular mils and a rectangular cross-section 1.158 circular mils by 1.278 circular mils.

The primary winding of No. 18 wire was chosen to give a field strength of twenty dynes per ampere of primary cur-

rent, and the secondary winding had 350 turns of No. 26 wire.

A Rowland D'Arsonval galvanometer whose calibration curve was accurately known, was used ballistically in obtaining the first hysteresis curves by the step-by-step method. The calibration curve of such a galvanometer is generally not a straight line, and this fact, combined with the change of the logarithmic decrement with various external resistances renders the computations somewhat laborious, since the factor of reduction depends on the size of the deflections and on the total secondary circuit resistance. It has the advantage of having a definite control, not depending on the earth's magnetic field, and for this reason has tempted many to use it in connection with ballistic methods for magnetic induction. Unfortunately in many cases the instrument is assumed to have a constant; that is, the factor to change from deflections to inductions is taken the same for all deflections. This is certainly not the case in many instruments of this type.

Later on in this work the Rowland galvanometer was discarded and a Nalder instrument of the suspended astatic needle type was used. This was provided with a thick laminated iron shield to exclude external magnetic disturbances, and proved to be very satisfactory. The logarithmic decrement, or damping factor, was so small, even on closed circuit, that it could be neglected, and it was therefore not necessary to calibrate it with a standard solenoid, but rather with an Elliot condenser and standard cell.

One of the principal difficulties encountered was the elimination of errors due to magnetic viscosity. This is the slow but very appreciable change of magnetic induction which takes place some time after the change in field has been made, and hence is not taken account of in the galvanometer deflection. Thus an additive error is introduced in the step-by-step method, depending on the number of steps made. We very early discovered that the maximum induction as determined by this method did not agree with that obtained by the method of reversals, and much time was spent in running down the discrepancy, which is by no means peculiar to electrolytic iron. In fact this part of the work is the subject of a separate report by one of us, to be published a few months later. Suffice to say here, that the additive errors due to viscosity may be eliminated by the following modification of the step-by-step method.

The primary P of the test ring (Fig. 1) is connected through the reversing switch C_2 and the single pole switch S_2 with the storage battery and ammeter A. The storage battery is connected with a sliding contact wire rheostat *r*, through the two switches S_3 and S_4, which have flexible leads with clips which can be attached to the rheostat at any desired point. The secondary of the test ring is connected through the resistance R_1, the switch S_1, the reversing switch C_1 and the control coil K with the galvanometer G. This is the same scheme of connections used in the ordinary step-by-step method. The modification lies in the method of procedure, which for that part of the hysteresis curve between saturation point and retentivity point is as follows:

S_3 is connected to the rheostat in such a position that the primary current is sufficient to produce a saturation field. S_4 is then connected at such a point on the rheostat that if S_3 were open a primary current would flow corresponding to any desired field less than the saturation field. At the end of any observation the switches will be in these positions: S_1 closed, S_2 closed, S_3 open, S_4 closed. For the next observation, the procedure is as follows:

Open S_1. Set S_4 for the next primary current desired corresponding to a field less than for the previous observation. Close S_3, bringing the iron to saturation point. Close S_1 and bring the galvanometer to rest with the control coil K. Then finally, open S_3, observing the galvanometer throw. This gives the change in induction from saturation point to any desired lower field, and the method is the same for all points between saturation point and retentivity point.

For the points between retentivity and negative saturation the induction changes are reckoned from the retentivity point, and the switches at the end of an observation will be in the same positions as for the first case. For the next observation the procedure is as follows: Open S_1. Set S_4 for the next primary current desired. The induction will have some value such as at X on the largest curve, Fig. 2. Reverse C_2, and close S_3, bringing the iron back to saturation point. Open S_2, bringing the iron to retentivity point. Reverse C_2 again. Close S_1 and bring the galvanometer to rest. Close S_2, and observe the deflection of the galvanometer. This gives the change in induction from retentivity point to any point such as X. The method is the same for all points as far as negative saturation. The other branch of the curve is done in the same way. It takes nearly twice as long to run a curve by this method as by the step-by-step method, but the errors due to magnetic viscosity are practically eliminated.

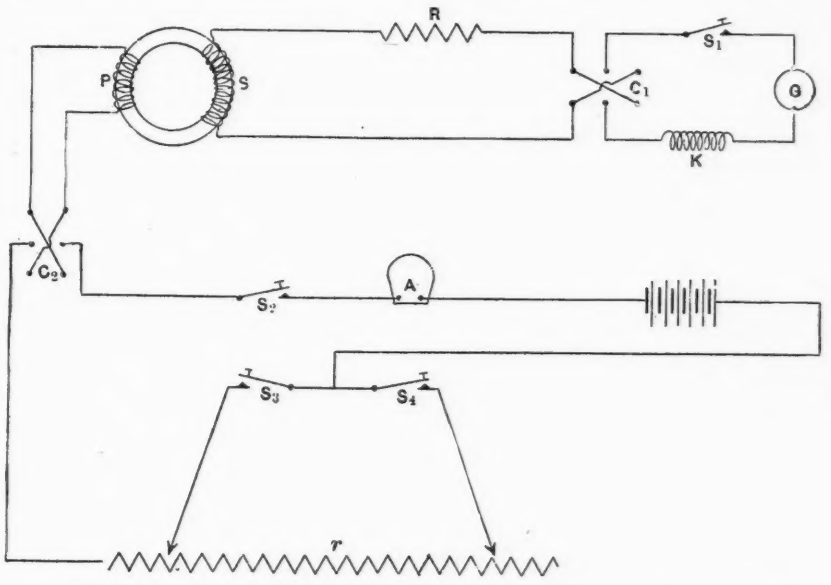


FIG. 1.—DIAGRAM OF CONNECTIONS FOR DETERMINING THE MAGNETIC PROPERTIES OF ELECTROLYTIC IRON.

Curve 1, Fig. 2, was not obtained by this method, as we were not at first aware that the magnetic viscosity existed to any serious extent in the electrolytic iron. The values of B are probably several per cent too low, but the curve shows several rather remarkable properties. The iron is evidently very hard, as indeed, its other physical properties show. The coercive force is eighteen dynes, and the retentivity 10,000. This would have come a little higher had the viscosity error been eliminated. It

seems that the field of 210 dynes does not saturate the iron, although it carries the induction to the high value of 21,250. At the same time there is relatively little area added to the hysteresis loop by running the field so high.

It is known that heating causes the liberation of hydrogen from electrolytic iron, the evolution beginning at comparatively low temperatures and increasing as the temperature is raised. The test ring was heated for several hours at a temperature of 200 degrees centigrade and magnetic tests again made. These gave a curve almost identical with the first, and showed either that it is not the hydrogen in itself which contributes to the magnetic properties of electrolytic iron or that the amount of hydrogen liberated was not sufficiently great to materially alter the magnetic measurements.

The ring was then unwound, embedded in magnesium oxide, and heated for eight hours at about 1,200 degrees centigrade. In this process a small portion was corroded on one side, necessitating the turning down of the ring, and hence a different choice of windings. The ring was found to be much softer than at first, and on being tested with the step-by-step method, gave values for the magnetic induction 17 per cent lower than those obtained by the method of reversals. As explained earlier in this paper, this was traced to magnetic viscosity, and a modified ballistic method was devised to eliminate the error. The dotted curve we obtained by this method, and comparison with the large curve shows that a tremendous change had taken place with the heating at 1,200 degrees centigrade. The iron is now in the condition of a rather soft steel, with a coercive force of about 2.5 dynes, a retentivity of 12,500 and a large amount of magnetic viscosity in the steep parts of the curve. A second heating of the ring to over 1,200 degrees centigrade produced no appreciable change in the magnetic properties.

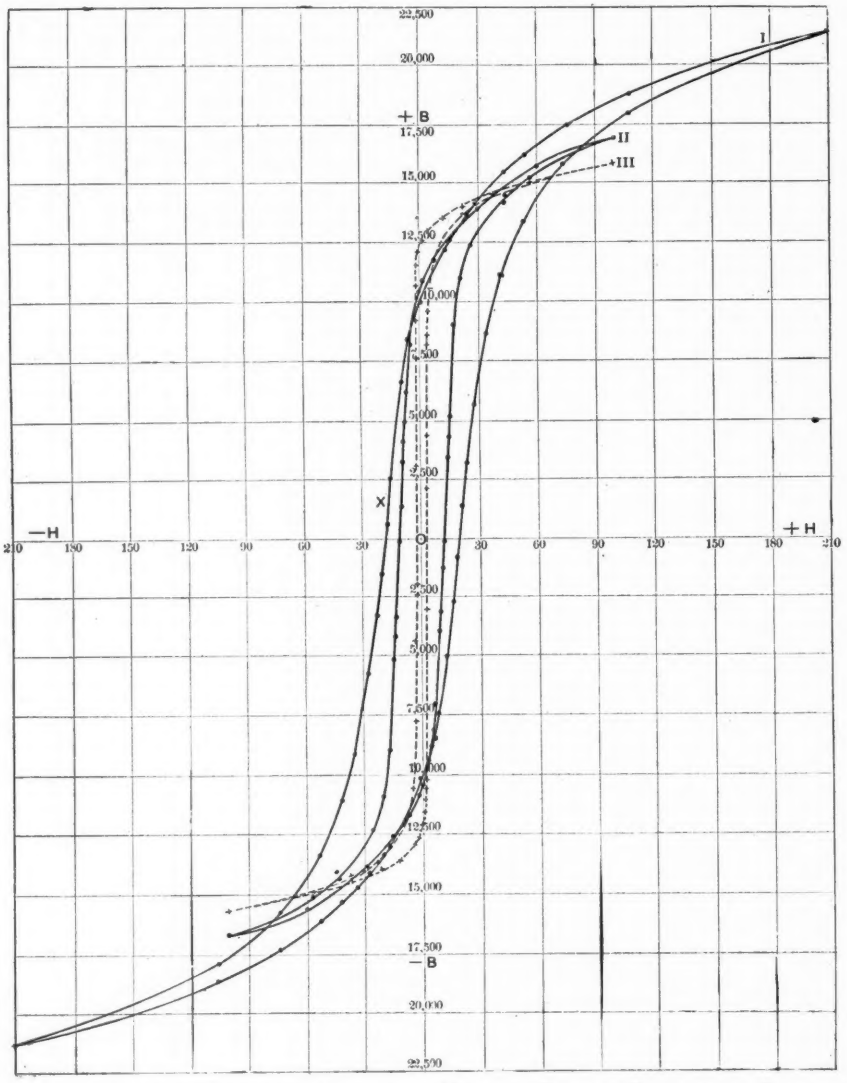


FIG. 2.—CURVES SHOWING THE RESULTS OF MAGNETIC TESTS OF ELECTROLYTIC IRON.

Another ring was prepared of electrolytic iron deposited from a solution maintained more nearly neutral than in the former case, the deposit being somewhat less hard and brittle and the fracture showing a finer crystalline structure. The mean radius of this ring was 4.175 circular mils; the width of face 0.97 circular mil; and the thickness 0.768 circular mil.

The primary turns were 418, and the secondary 350. The curve II was obtained from this ring by the modified ballistic method, and is evidently like curve I except that the peculiarities are not so marked. A field of 100 dynes gives a maximum induction of 15,750, and a retentivity of 10,300. The coercive force is eleven dynes. The iron is still very hard but its other physical properties also indicate that it is not so hard as the first sample.

After some further tests have been made on this ring it will be heated to various temperatures and tested, with a view of determining at just what temperature the area of the hysteresis loop begins to change rapidly.

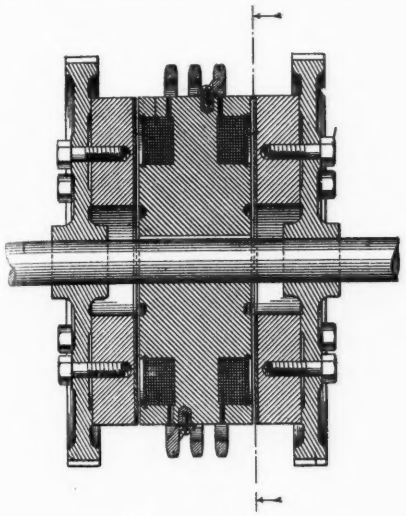
Magnetic viscosity is usually found in rather soft steels, of low coercive force, or even in many samples of soft iron. It was therefore a matter of surprise to find that the step-by-step method gave values of the maximum induction for ring II six per cent lower than those obtained by the method of reversals, and by the modified ballistic method. This indicates a considerable amount of magnetic viscosity. We hope to have some laminated annealed rings in the near future, and to continue this investigation with these and with some rod samples, as well as with the rings already on hand.

Electricity and Tank Experiments.

At Ubigau, near Dresden, there is an institute for carrying out various kinds of hydraulic experiments, including the measurement of the resistance of models of ships to propulsion. This institute, which is in connection with the Technical High School of Dresden, has recently been provided with a new experimental tank, says the *Electrician,* London, about 260 feet long and twenty-three feet wide. The ship models are drawn through the water by means of a traveling bridge, which runs on rails fixed at the edges of the two long sides of the tank. In order to obtain rapid acceleration and retardation, the traveler was built as light as possible, and the bridge, complete with its electric driving equipment, weighs only four and one-half tons. It is driven by a twenty horse-power shunt motor, and the general electrical and mechanical arrangement is analogous to that adopted in crane practice. Current is conveyed to the motor on the traveler by a third rail and contact shoes, and returns through the rails. The speed is regulated by varying the supply voltage on the Ward Leonard system. The operator controls the traveler from a small switch desk at one end of the tank.

Electrical Patents.

George A. Damon, Chicago, Ill., has obtained a patent (821,024, May 22) for an improved magnetic clutch, which he has assigned to the Arnold Magnetic Clutch Company, Milwaukee, Wis. This invention re-

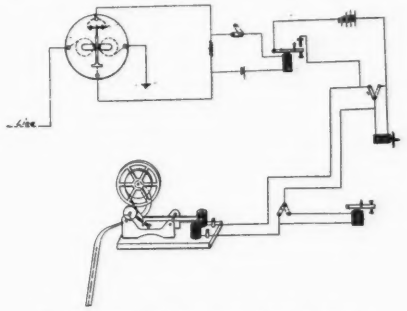


MAGNETIC CLUTCH.

lates to improvements in magnetic clutches. In devices of this character there is always a tendency of the members to remain clutched after the exciting coil has been deenergized owing to residual magnetism. Various mechanical means have been devised to free the members simultaneously with the opening of the magnetizing circuit, but no efforts have been made to overcome the residual magnetism other than to construct the parts of metal which will retain the least amount of magnetism. The object of the invention is to destroy the residual magnetism within the members immediately upon deenergizing the coil which creates the same in order that the members may quickly separate. This is accomplished in the preferred form of the invention by providing two exciting coils which will produce magnetic fields in proximity to each other having lines of force moving in opposite directions. When one coil is excited the other is deenergized, and the magnetic field of the excited coil will destroy the residual magnetism in the field of the other coil by reason of the lines of force of these fields moving in opposite directions, and the magnetic field of the energized coil being stronger than the residual magnetism of the other field.

Walter G. Clark, of New York, has obtained a patent (821,017, May 22) for an improved composition of matter for electric conductors, and he has assigned the same to the Parker-Clark Electric Company, Jersey City, N. J. This invention relates to improvements in refractory conductors such as are suitable for films or filaments in electric lamps. The object of this invention is to produce a refractory conducting material which can be applied to the inner walls of a nonconducting refractory tube as a film or lining or used as a filament for the common type of incandescent electric lamp, and which will be harder and more durable than the carbon films or filaments in their various forms or combinations. This invention is also intended to produce a composition which has the property of being a good conductor when cold and which has a less variable conductivity under temperature variations than most refractory and high-resisting conductors. It is found that by effecting a combination of carbon and silicon in either the form of a film or filament, the composition can be made in a very simple manner, so as to produce a structure harder and better adapted for lighting purposes than the usual forms of carbon.

An improved electric telegraphy has been invented by Isidor Kitsee, of Philadelphia, Pa. (820,977, May 22, 1906). This invention relates to an improvement in telegraphy, and has more special reference to the receiving of telegraphic intelligence on submarine or long-distance lines. In letters-patent 777,259, dated December 13, 1904, the inventor describes a method of telegraphing over submarine or long-distance lines with the aid of true reversals. The present invention has special reference to the receiving of such true



ELECTRIC TELEGRAPH APPARATUS.

reversals, even over long-distance submarine; and it is the object of this invention to receive such true reversals over long-distance cables in a manner so that the same may be recorded in accordance with the Morse method of recording or may be relayed to a second cable or to land lines. The invention consists in the combination with a line of transmission, a receiving device consisting of a polarized relay provided with contacts, a closed local circuit embracing a source of current, an electromagnet and a resistance of a value great enough to normally make the electromagnet inoperative, a shunt around the resistance, one terminal of the shunt in electrical contact with the movable part of the relay and the second of the terminals in electrical connection with the contact of the relays, and means at the relay to shunt through the movable part, the resistance, thereby making operative the electromagnet.

An Old-Time Thunder Storm.

Among some old manuscripts has been found the following account of an "Eminent Deliverence from Lightning," as related in 1688 by the Rev. John Hale, pastor of the Beverly (Mass.) First Parish, in a letter to his brother Wilson at Charleston.

The double date is due to a custom of the Puritans in beginning the new year March 1.

Febr: 19, 168 $^{8}/_{9}$

His relation whereof is this. My wife, two maids & two children were by y^{e} kitchen fire; myself with Deacon Hill in my study & hearing y^{e} thunder smart, were going down to Comfort y^{e} family & as we came to y^{e} head of y^{e} Staires (D. Hill part down) we were both struck wth Lightning in our right Armes & right Legs, yet neither of us heard y^{e} thunder or saw y^{e} Lightning; He was less strook, & sooner got down staires; I was struck down upon my knees, by y^{e} post we used to lay hands on, as we goe up & down staires & unable to stirr for some time; but heard som of my family crying out of hurt below; at last I got down, my foot as it were dead, & leg full of paine, but wth help got to lie down on a bed; my elbow seemed out of joynt, & Arm hung down like a stick; wth m^{ch} paine in it, but my fingers seemed dead: I have a bruise on my face, but suppose it might be wth my fall. In less y^{n} hour I found life in all my limbs, & that no bone was broken or joynt, unless some small starting out of a bone in my wrist (praised be y^{e} Lord) I find y^{e} post I was by, shivered on 3 sides. But to come to y^{e} Rest; y^{e} Lightning came down y^{e} chimney, brake out some bricks just above y^{e} mantle tree; Hurt my wife and English maid on their heads, & y^{e} negro on her right Arm, yet all pretty well againe (thro' mercy) it bowed out two paines of glass in y^{e} kitchen, but brake out no glass & on y^{e} other side of y^{e} house beat out y^{e} bottom of a paile, and touched severall pewter platters: on y^{e} top of y^{e} kitchen Chimney it brake out 20 bricks: and on y^{e} other side of y^{e} roof made an hole about 8 foot long & then beat out y^{e} North end of y^{e} kitchen about 8 foot long & 3 foot wide, & tore out many other boards at y^{e} end. Without doors it killed me a cow, and in y^{e} stable one Lamb w^{ch} the Lord accepted of instead of our lives. How unsearchable are his ways & paths past finding out &c. I find no mark on my body but a blue spot on my heele a ¼ of an inch long & ½ so wide & somewhat sore & one spot on y^{e} sole of my foote but not sore.

Reviews of Current Engineering and Scientific Literature.

Measurements of Atmospheric Electrical Potential.

An analysis of the atmospheric electric results at the Kew observatory from selected days, usually ten a month, during the seven years from 1898 to 1904, has been made by C. Chree. The days were chosen as representative of fine weather conditions, all days being excluded when rain fell or negative potential was recorded. By means of regular observations with a portable electrometer, the curve readings from the Kelvin water dropping electrograph were converted so as to give the potential gradient in the open in volts per metre. All the data—mean monthly values, diurnal inequalities, etc.—are given in absolute measure (volts per metre). This is believed to be the first occasion on which this has been done. The diurnal inequalities for individual months and for the whole year are represented by curves. These are mostly exceedingly smooth, thus showing that a sufficient number of years' data have been included to give satisfactory results. The curves all show two distinct daily maxima and minima. The minima occur in all the months near 4 A. M. and 2 P. M. The times of the maxima are more variable, the day interval between the forenoon and the evening maximum being longer in summer than in winter. The month showing the highest mean potential gradient is December, but the amplitude of the diurnal inequality is greatest in February. The diurnal inequalities for the several months are analyzed in Fourier's series with twenty-four, twelve, eight and six-hour terms. The twelve-hour term is, in general, the most important, especially in summer. The changes in its amplitude and phase angle throughout the year are comparatively small. The twenty-four-hour term is more variable. It is much larger in the winter than in the summer months, and its phase angle varies greatly throughout the year. The difference between the values of the potential gradient at successive midnights of these selected days, when taken irrespective of sign, averages about forty-three per cent of the mean daily value. When taken algebraically there seems a slight tendency in the potential to raise during the selected days in December and January; but, taking the year as a whole, the mean non-cyclic element is exceedingly small.—*Abstracted from the Electrician (London), May* 18.

Causes and Prevention of Faults in Direct-Current Networks.

This article deals with faults which develop in underground networks laid on the so-called solid system. The author, Mr. F. Fernie, has had a large amount of experience with such systems, and he here points out the nature of the faults most frequently met with and the proper methods to be adopted in order to minimize this trouble. In popular language, a negative fault draws water on account of the effect called electric osmosis. This phenomenon can easily be observed by inserting two wires, connected to the opposite sides of an electric supply system, in apparently dry soil. After a short time moisture will be found to have collected around the negative wire. Further, if a current be passed through a vessel divided into two compartments by means of a porous partition, it will be found that the solution with which the vessel is filled will be transferred partially from one side to the other, the transfer usually being in the direction of the current. It is this effect which the author thinks is largely instrumental in causing faults in buried cables. Abnormal osmotic pressure is set up at the insulation, causing decomposition to take place and forcing water to penetrate through the insulation wherever it is weak. Although faults of various kinds, due to mechanical troubles, chemical troubles, etc., are met with, these faults operate equally against both sides of the system. Nevertheless, ninety per cent of all faults occur on the negative main. For this reason it is believed that the faults which occur in this main are most generally due to electric osmosis. To test this effect the author buried a highly glazed earthenware pipe in the ground, the lower end being placed in a box and tightly sealed with bitumen. The top was protected by a cover. The outer part of this pipe was wound with bare copper wire and another spiral was placed inside. After standing fourteen days, during which time water was daily poured into the ground around the pipe, the interior remained perfectly dry. Then 230 volts were applied to the two wires. Within one hour beads of water appeared on the inside, and in two days the pipe was half full. The walls of the pipe were one-half-inch thick. On reversing the polarity of the wires the water disappeared and the pipe became perfectly dry. Whenever a weak spot develops in the insulation of a buried cable the tendency is to keep the fault dry if the conductor be positive; and, on the other hand, to force moisture through the fault if the conductor be negative. Not infrequently, when faults on negative conductors are laid bare, large encrustations of salt are found about the wire, and sometimes a considerable body of water is found within the rubber, causing it to bulge out from the wire. As further evidence supporting this theory, the author cites his experience with railway systems in which the feeders are laid underground. He can not recall a single instance in which a fault developed on these positive conductors; hence to protect a conductor it should be maintained above the potential of the earth. On the other hand, a positive fault throws additional strain on the negative insulation and is apt to cause breakdowns of that wire. From these considerations it appears that for three-wire systems a triple concentric cable will be the safest to use. The inner core should be the negative, the middle the third wire and the outer the positive conductor. These considerations lead the author to prefer a draw-in system to the solid system. Not only are faults less likely to develop on account of this osmosis, but there is less danger of mechanical injury, and there is no need to lay down in the first instance conductors of sufficient size to provide for all expected development. With such a system there is little danger of mechanical injury, though chemical injury may occur, particularly where wooden ducts are employed. To prevent electrolytic action the lead sheathing of cables should be broken at every service joint. When this is done it is suggested that the sheathing of the service wire be bonded to the sheathing on one side of the joint only.—*Abstracted from the Electrician (London), May* 11.

The Woolwich Works of Siemens Brothers & Company, Limited.

The Woolwich Works of Siemens Brothers & Company, Limited, were established in 1864 by the firm of Siemens Brothers, of Westminster, to replace a small factory at Millbank Row, which had been started in 1858 by William Siemens, for the manufacture of telegraph and other electrical apparatus. About 1878 the firm commenced the construction of dynamoelectric machinery. In 1880 the firm was reorganized as a limited liability company under its present title. The dynamo and

motor branch of the business was recently transferred to Stafford, where extensive works were erected. The area covered by the Woolwich Works is now about fifteen acres. The north side is bounded by the Thames, and all the important shops and yards are traversed by a system of trolley lines running from east to west, while a telpher transport system runs south to north between the line department and the wharf, the two systems allowing of an interchange of goods being effected. The works proper comprise submarine cable shops and tanks, railway signaling shop and electrical accessory stores on the north side of the main yard, the large shops for the manufacture of electrical apparatus occupying the first and second floors. On the south side are situated the power-house and a large number of shops allotted to the many processes entailed in the manufacture of cables insulated with gutta percha or India rubber, while the top floors are utilized for meter and instrument testing, bobbin winding and lacquering. The whole of the eastern extension is taken up by the electric light and telephone cable shops and the main office buildings. The southern extension contains the line department, sawmills and joinery shops, tinning, jute, winding sheds and several store buildings. Electrical transmission by continuous current at low voltage carried to all parts of the works by underground mains is adopted for driving tools separately or by countershafts, as is found most convenient. All the shops are electrically lighted by Siemens arc and incandescent lamps. The small shops, which were started in the original building for the manufacture of telegraph instruments, have grown to such an extent that they and the extensions which have from time to time been found necessary form a works in themselves. The work turned out is no longer restricted to instruments, but includes articles up to the largest searchlight projectors. The power-house is situated centrally in the works. Steam is raised by five Laird gunboat type boilers and two Babcock & Wilcox boilers arranged for the use of natural and induced draught. The generating plant comprises five 300-horse-power steam engines direct-coupled to Siemens continuous-current, shunt-wound dynamos, each having an output of 1,500 amperes, 120 volts at 350 revolutions per minute. Three of the engines are of the Willans compound, three-crank type, one of the Bellis enclosed, three-crank type, and one of the Sisson compound, two-crank type. The works are provided with a fully equipped chemical laboratory, in which samples of the various materials in use are tested. There is also a suitably equipped engineering shop for carrying out local repairs. The main offices consist of a three-story building, in which are housed the clerical departments, manager's office, drawing offices and other clerical departments.—*Abstracted from the Electrical Review (London), May* 18.

The Direct Production of Copper.

It has been the aim of electrometallurgists ever since copper refining was introduced by Messrs. Elkington in the year 1869 to increase the rate at which copper can be deposited in a smooth form without any considerable increase in voltage, which means increased power and corresponding cost. The object of increasing the rate at which copper can be deposited is to reduce the capital outlay and the amount of copper under treatment, which is an item of great importance in works of any size. The current density employed in electrolytic refineries has been increased from about eight or ten amperes, as originally employed by Messrs. Elkington and Messrs. Elliotts, of Birmingham, to twenty amperes per square foot as at present employed by the Anaconda works in America. The usual current density employed in the centrifugal process, herein described, is 200 amperes per square foot of cathode surface, the voltage at the terminals of the deposit cell being 0.75. To enable finished products, such as copper tubes, sheets and wire, to be made direct in one operation from crude copper by electrodeposition, it is necessary to greatly increase the rate at which the copper is deposited, as compared with the rate at which copper can be electrically refined. To enable copper to be quickly electrodeposited the electrolyte must be rapidly circulated so as to prevent the electrolyte being deprived of its copper ions in proximity to the cathode. The conditions must be such that no metal other than copper is deposited, and the electrical resistance must be kept low. The ideal electrolyte would be one that is chemically inert as a solvent, but capable of dissolving copper electrochemically and having a low specific electrical resistance. These conditions have so far been met by the use of an acidulated copper sulphate solution, though this is far from ideal. Various attempts have been made from time to time to further increase the current density by using mechanical means for keeping the copper smooth during the process of deposition. The best known of these is the Elmore process, which employs an agate burnisher, which continually traverses the surface of the copper being deposited. The Dumoulin process employs a sheepskin rubber, the object being to insulate, by coating with grease, the raised portions of the copper as soon as it becomes rough, so as to cause the lower portions of the copper to be built up to the same level. The impingement of the electrolyte against the surface being deposited on has also been tried. The Cowper-Coles centrifugal process is distinct from any of these, inasmuch as it consists of revolving the mandrel on which the copper is deposited at a critical speed. It is found that, for a given current density, the mandrel must have a certain peripheral speed. The greater the speed the greater the tensile strength of the copper. The result of revolving the mandrel at this comparatively high speed is that every molecule as it is deposited is burnished or rubbed down so as to produce tough, fibrous copper, the usual order of things being reversed, the present practice being to put the mechanical work into a mass of copper instead of treating each molecule as it is deposited. The centrifugal action throws off any foreign matter held in suspension and prevents the formation of nodules. A point of particular interest about the Cowper-Coles process is the method of making wire or strip. The apparatus employed consists of a vat, annular in construction and containing a mandrel which may readily be withdrawn. The amount of electrolyte required is greatly reduced, and an ordinary vat is capable of making wire three or four miles in length. The mandrel for the production of wire has a fine spiral scratch made on the surface. This scratch is angular and not of rounded section, otherwise the copper will not divide. The effect of this scratch is to alter the crystalline structure of the deposited copper and form a line of cleavage similar to those formed in cast metals with sharp angles. The copper is deposited in the usual way, but when the end has once been started it can be unwound in a continuous strip. Copper obtained by this process gives a remarkably high tensile strength. Copper tubes, without any drawing, have been given a maximum stress of seventeen tons, and a tube, after drawing, has stood a pressure of 3,000 pounds per square inch with a thickness of metal of 0.063 inch. Sheets, without rolling, have given a maximum stress of from twenty-eight to thirty-four tons per square inch.—*Abstracted from Engineering (London), May* 18.

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

BUSINESS-GETTING METHODS.[1]

BY FRANK W. FRUEAUFF.

The writer feels that the best results in getting business are secured through systematic solicitation followed up and interwoven with general and personal advertising. We must see our customers, know their wants and aim to supply them. In many cases we must begin by creating a desire for what has seemed a new article or an expensive luxury. Solicitors or representatives must be thoroughly drilled in their work and should be conversant with the general methods of manufacture in order to intelligently approach the possible user.

We have found that best results are secured by a constant interchange of ideas among the men engaged in the same line of work, and by a constant and continual drilling and education of the men by some one well posted on the subject. At the outset, it is well for a new man to go about with one who has solicited before, and in that way learn the general line of arguments that are used to induce the consumer to buy; to learn to make a favorable impression upon the prospective consumer, how to adjust complaints, if made, and how finally to close an order. We have found that while many men are thoroughly posted on the advantages of the use of electric light or power, they are not able to hold the interest of the customer, and it is of prime importance that they know how to present the proposition.

Too much attention can not be given by the representative to the complaints, either real or imaginary, which come to his notice. Too much stress can not be laid on the satisfactory results that can be secured by judicious advertising in connection with the visits of the solicitor.

The sending of attractive advertising, showing forcibly the benefits to be derived by purchasing what we have to sell, will enable the representative to close many orders.

The sending of letters to prospective customers unless followed up within a reasonable time by a trained solicitor can not be expected to accomplish results. Many people are in a receptive mood after reading advertising matter, and if we can call and see them soon after, we can get their business, but they will not take the trouble to go down and look for the man who has it to sell. This applies in every line of business, and probably more so in ours than with the so-called retail establishments.

One of the very important features in the getting of new business is in the persistency that is used by the company. We can hardly hope to secure results that would justify any part of the expense of a new business campaign unless it is followed up persistently and systematically.

One visit to all of our consumers or prospective customers will not accomplish much. In many cases the first visit will scarcely give the solicitor an opportunity to meet the consumer, or the entire interview will be taken up with the discussion of the company's policy or in the discussion of some grievance, but it must be borne in mind that these interviews, while not directly productive of good, in the long run are bound to pay handsome dividends.

Our experience, covering a period of several years, shows that the most of our orders are closed after the fourth or fifth visit, and that practically no orders are taken the first time a prospective customer is seen. We have found, too, that where solicitation has been followed up and interwoven with general advertising and with special letter writing, the number of visits has been cut down and the orders secured on an average of about three visits.

The statements just made apply only to the business and commercial districts. In the residence districts we have found it comparatively easy to secure lighting orders on the second visit, but it takes a great many visits to increase their consumption through special uses, such as for long-hour burning of porch lights and the use of special appliances, such as sewing-machine motors, curling-iron heaters, chafing dishes and so forth.

Coming down to a specific branch of business getting, we strongly recommend the use of specialists in particular lines. For example, we have found that a man well versed in the building and designing of electric signs is of material assistance to the representative; that is, while the representative is able to interest the merchant in a proposition for a sign and to convince him of its desirability for his business, if he can then bring to the merchant a man who can give him ideas on how his place may be lighted and advertised to bring out his particular line, it will bring more satisfactory results for the merchant and will usually enable us to secure a larger and more permanent proposition.

We have a man who devotes all of his time to drawing sketches that are submitted by the representative and sign expert. Oftentimes half a dozen sketches are submitted, after the merchant has concluded to put up a sign, before any of them catches his fancy, but it pays well to go to this expense and have him thoroughly satisfied at the outset that he has something particularly adapted to his case.

It is the same with the solicitation of electric power. A special man, who is thoroughly posted on the adaptability of electricity for motive power, can bring the merchant to the closing point much more quickly than if the work is undertaken alone by some man who is fairly well versed in all parts of the business, but is not a specialist in this line. Another specialist who is of great value to the lighting company is a man to follow up new buildings.

One of the most profitable sources of business lies with our present users in increasing their standard of illuminating, and, with business houses, in impressing upon them the possibility for display lighting. This particular part of the business is to be commended. Practically no further investment is needed to secure this business, consequently the profits are very much greater than where new connections have to be made, and once having made a start with the merchant it is easier to get him to use more. With many of our sign, window and outlining consumers we have increased their use of light two or three fold, as the advantages of this class of business have impressed themselves on the merchant's mind.

Summing up the conclusions briefly, I feel that business-getting methods may all be embraced in going after the business systematically, persistently and discreetly, and the more of this that is done the faster the company will grow, the safer its position will become in the community and the greater its earning power for its stockholders.

[1] Read before the National Electric Light Association at its twenty-ninth convention, held at Atlantic City, New Jersey, June 5, 6, 7 and 8, 1906.—Abstract.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

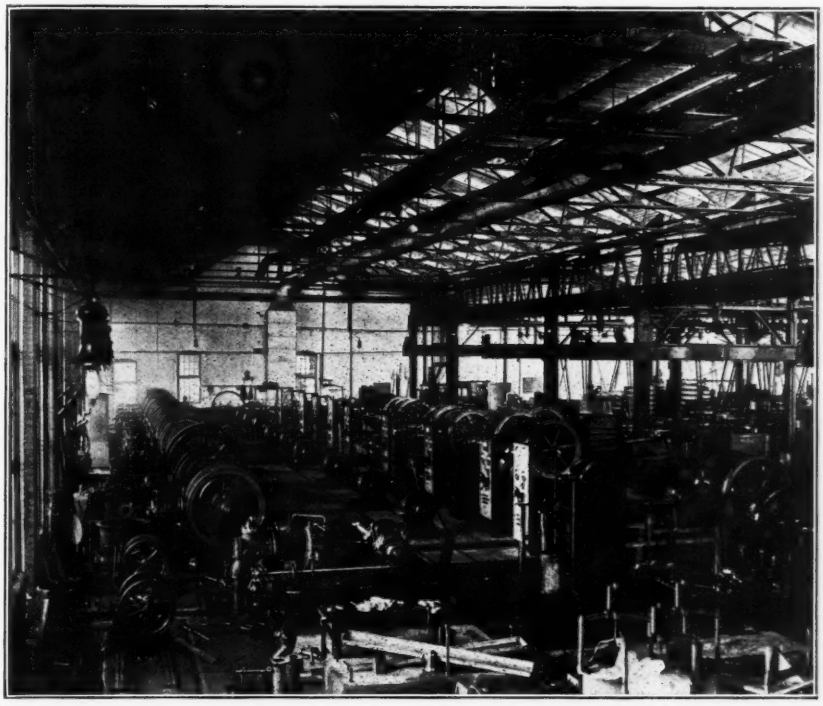
The Electrical Equipment of the Factory of Olds Gas Power Company, Lansing, Mich.

The building occupied by the Olds Gas Power Company, of Lansing, Mich., is laid out in the form of the letter L, with the top projecting toward the west. The castings for the engines are made in the foundry of the Olds Motor Works, and are delivered into the west end of the engine factory, worked through the cleaning department and machine shop, and assembled near the east end. After assembling, the engines are placed upon a foundation with slotted rails, called the working-down stand, on which the bearings, cylinders and other wearing parts are worn down to good bearing surfaces, the power being derived from a line shaft driven by other power. When in condition for operation they are taken to the testing stand, which is similar to the working-down stand just described and is located at the east end of the main building and provided with slotted rails, and after test to the paint room at the north end of the wing where they are painted and loaded for shipment.

The castings and other engine parts are handled by means of three five-ton, three-motor, electric traveling cranes from the point of entrance at the west end of the main part of the building to the north end of the wing, and the progress of the work is entirely in one direction from the time the parts enter until the completed engine leaves the factory.

A novel feature of this operation is that nearly all the power used is generated by engines under test. On a long foundation adjacent to the testing stand there are located eight generators with an aggregate capacity of 168 kilowatts, and ranging from thirty-five kilowatts to ten kilowatts. Each generator has its individual switchboard. These generators are compound-wound for 250 volts, direct current, constant potential, and, with the exception of one Westinghouse type M, all are Westinghouse type S. Generators of different capacities were installed to provide one of suitable size to load each engine manufactured by the company, the engines ranging from eighteen to fifty horse-power. Beneath the floor on which the switchboards are located is a passage about six feet six inches deep, in which are run the bus-bars and connecting conductors. From the south end of the main bus-bars, four 500,000-circular-mil lead-covered cables connect to the distributing switchboard in the southwest corner of the testing department, from which the several sets of distributing mains run to the various parts of the factory and to the office building.

The general lighting is obtained from 122 constant-potential, direct-current, 120-volt arc lamps, each controlled by a snap switch on an adjacent column, and 476 120-volt, sixteen-candle-power incandescent lamps are installed for special lighting at tools, benches, etc. Three-wire mains are employed in this service with a four-kilowatt motor-generator balancer connected to the three-wire bus-bars for the purpose of equalizing the voltage should the load between the neutral wire and either of the outside conductors become unbalanced. As a safeguard against unbalanced loads the lamps are connected alternately between the neutral and the positive and negative leads. In order that the load between the two sides of the lighting system may be balanced, the sixteen arc lamps in the immediate vicinity of the distributing switchboard are connected on four sets of mains, each provided with a double-throw switch on the distributing switchboard, so that all these lamps or any number of the four circuits may be connected to either side of the system at the will of the operator. A double-reading ammeter is located immediately above these switches and a pilot lamp is mounted on each side of the ammeter, one lamp being connected between the positive conductor and the neutral, and the other between the negative conductor and the neutral. The reading of the ammeter and the relative brilliancy of the pilot lamps indicate the amount of unbalancing of the load.



ERECTING AND TESTING SHOPS, OLDS MANUFACTURING COMPANY.

Included in the general lighting is a watch light service consisting of a number of sixteen-candle-power incandescent lamps distributed at wide intervals in the factory for general dim lighting and for watchman's service. These lights are also connected to a double-pole, double-throw switch at the switchboard and may be thrown on either side of the system for the purpose of balancing the load.

All power circuits are 240-volt, two-wire, and are connected to two-wire mains controlled by double-pole switches at the dis-

tributing switchboard. The heating fan motors are all connected to one set of mains controlled by a switch and a set of mains is run to each of the three traveling cranes with a switch, all switches being mounted on this distributing switchboard. A circuit-breaker is connected in the bus-bar circuit leading to the traveling cranes, so that in the event of a short-circuit on any of the cranes or upon the trolley wiring, this circuit-breaker will open, while those on the generator switchboards will remain closed, and the other operations of the plant will not be interrupted.

The wiring for lights and motors is in general run with cleats on wood posts bolted to the steel work and in "loricated" iron conduit down columns.

The method used in testing engines in this factory is a unique departure from the old-established practice and is considered much more accurate than a Prony brake by the engineers and architects, Field, Hinchman & Smith, of Detroit, who designed the building and its electrical equipment. After each engine is taken from the working-down stand it is placed on the testing stand and run for a short time with its own power. It is then belted to a generator of suitable capacity and run on a water rheostat until it is capable of carrying sufficient load to warrant connecting its generator in parallel with the other machines, at which time it is connected in parallel with the others by throwing over a three-pole, double-throw switch on its switchboard. A pilot light is provided upon each generator switchboard, which is lighted whenever a generator is carrying a water rheostat load, thus preventing the accidental connection of two generators in parallel on the rheostat without notice.

After the engine has run for a sufficient length of time to enable it to develop ten per cent more than its rated brake-horse-power, the generator is again connected to the water rheostat and the engine is given its test run. The power developed by the engines is at all times shown by indicating wattmeters, one of which is mounted on each switchboard. These instruments are of the horizontal edgewise type with two scales, one above the needle and one below. One scale is graduated to read directly the kilowatt output of the generator with which it is connected, and the other scale to read the corresponding horse-power delivered to the generator pulley. To obtain the various points of this second scale, the various kilowatts output were reduced to corresponding horse-power and then divided by the efficiency of the generator with which the instrument was to be used. The generators were all tested at the factory by the Westinghouse company, and copies of the efficiency curves were furnished to the instrument makers for use in calibration. By the use of one of these instruments the brake-horse-power delivered to a generator which is being driven by an engine under test is accurately indicated at all times. If there should be belt slippage, this power, of course, would be less than that generated by the engine; but, as all the generators have belt-tightening bases, this slippage can be made so small as to be practically negligible. At all events the reading will not favor the engine and the power delivered at the engine pulley will be equal to or greater than the reading of the instrument.

Again, should a generator be operating at a lower efficiency at the time of the test of an engine than at the time of the factory test of the generator, the reading of the wattmeter will be less than the horse-power delivered to the generator. Consequently, the maker of the engine is always abundantly safe in guaranteeing the output as obtained by the readings of one of these wattmeters.

In addition to the three-pole double-throw generator switch, the water rheostat pilot lamp and the indicating wattmeter already mentioned, each generator switchboard is equipped with a circuit-breaker, an ammeter, a voltmeter, the field rheostat for the generator, a ground detector and two lamps, one connected to the main bus-bars and located over the voltmeter, and one connected to the generator leads and located over the ammeter.

The equalizers for the generators are all connected through the middle blades of the three-pole switches to a short equalizer bus-bar near the thirty-five-kilowatt machines, the endeavor being made to keep the connection to the generators of such size and length that the drop in potential over them will be the same in each case if the equalizer connection carry the full load of the generator.

A room has been provided in the basement under the testing department for the future installation of a storage battery, so that if there should come a time when the ordinary shop load would not be sufficient to provide loads for testing, the storage battery can be charged and then discharged on night loads for lighting and the operation of heating fans and for extra heavy day loads. As a further provision for additional load a second water rheostat has been provided with a connection from the bus-bars on the distributing switchboard. This water rheostat is controlled by a switch on the distributing switchboard, and a single-pole circuit-breaker is connected in one side of the circuit. Up to the present time, however, the shop load has been more than sufficient to provide loads for testing purposes, and there has been no need for the use of a storage battery or the second water rheostat.

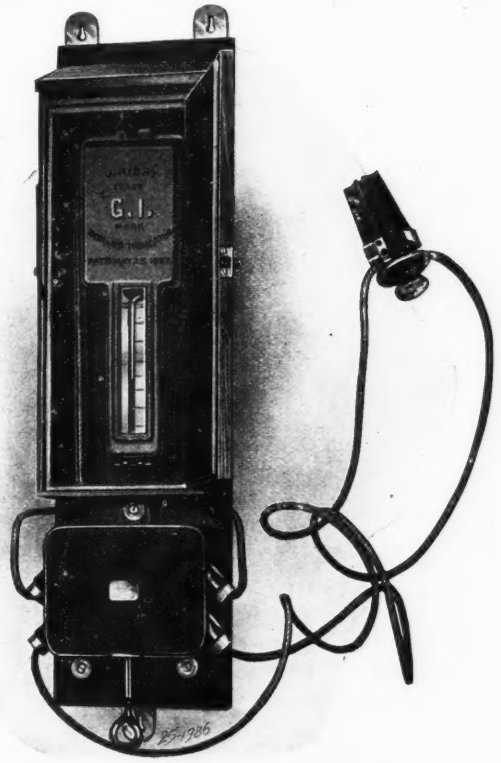
It might be interesting also to note the method of operation of the water rheostats. Each rheostat consists of an open steel tank, which forms the negative electrode, and a steel plate suspended inside and insulated from the tank, which forms the positive electrode. The tank is also insulated from the ground. The electrical connections to the two electrodes are made by means of lead-covered cables.

The saline solution, which may be made of any desirable strength by the use of variable quantities of salt and water, is forced by means of compressed air into the tank from a closed supply tank in the basement. The connection from this tank to the rheostat is of lead pipe incased in extra heavy rubber hose and the supply tank is mounted on insulating supports. An air line containing compressed air is run along the basement ceiling under the switchboards, and a connection is made to two three-way cocks at each switchboard, from each of which an air pipe runs to the top of each supply tank. A scale has been provided on the inside of the wall of the building opposite each rheostat and a pointer operated by a float in the rheostat tank indicates the level of the water in the tank. The operator can then stand at the switchboard and, by throwing a three-way cock in one direction, admit compressed air to the supply tank and the level of the solution in the rheostat tank will be raised and the load increased. By throwing the handle of the three-way cock in the opposite direction, the air in the supply tank is released to the atmosphere, the water in the rheostat tank runs back into the supply tank and the load is decreased. Thus, by the operation of the three-way cock the load may be adjusted to any desired quantity. One three-way cock is used for each of the rheostats above mentioned.

In conclusion, it may be noted that practically all the time since its installation the plant above described, with the assistance of one fifty-horse-power unit, has carried its load of 250 to 450 amperes with but few interruptions and with but minor difficulties.

Portable Form of Wright Demand Indicator for Outdoor Work.

The Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass., has recently placed on the market a special portable outfit for the use of the Wright demand indicator in outdoor work, which is shown in the accompanying illustration. The outfit includes a weatherproof housing and insulating board fitted with hangers to be attached to the crossarm of the pole beside or near the transformer. Mounted at the bottom of the board is a "Wood" arc circuit cutout, which serves to shunt the Wright indicator and to disconnect it from the circuit without interrupting the latter. The attaching plug is permanently connected to the indicator leads, so that the entire equipment is self-contained and may be removed intact.



PORTABLE FORM OF WRIGHT DEMAND INDICATOR.

To test a transformer it is only necessary to install the equipment on the crossarm and substitute the attaching plug for one of the fuse plugs from the primary fuse box. As the Wright demand indicator records the maximum current which has passed through it any time since it was last set, it may be read at any desired period after being connected—an hour, a day, a week, or a month—and will show with absolute precision the maximum load which the transformer has had to carry since it was connected.

The instrument may be connected in the secondary circuit instead of the primary, if desired, in which case the arc cutout, which is interposed merely for safety in reading and resetting, becomes unnecessary. On the other hand, smaller and cheaper instruments may be used for connection in the primary circuit as well as the operation being more convenient.

Progress on the Electrification of the West Jersey & Seashore Division of the Pennsylvania Railroad.

Work on the construction of the electrified section of the trunk line railroad between Camden and Atlantic City is progressing rapidly. It will be remembered that the contract for the equipment and construction of this road was let to the General Electric Company last December and that the equipment was to be in operation by July 1, 1906. When the magnitude of the work is considered, the necessity for rapid and systematic construction can be realized.

In the first place the work must not interfere with the regular operating schedule of the present steam trains. As a consequence much track work has been done during certain hours at night. In addition to track work, bonding and pole-line construction, an 8,000-kilowatt generating station and seven separate substations are being erected and equipped. Progress on some of the substations has been phenomenal. At South Camden, Glasboro, Newfield and Reega, the substations are well under way, each containing two 750-kilowatt rotary converters with auxiliary apparatus with arrangements for a third complete set. At Mizpah and Clayville the equipment consists of two 500-kilowatt rotary converters with room for a third, while at Atlantic City two 750-kilowatt machines are being installed with an ultimate equipment to consist of two additional 1,000-kilowatt units. The eighth substation is at the main generating plant and contains two 750-kilowatt rotary converters.

The progress of the work will be clearly evident to visitors during the Atlantic City conventions. Leaving the Camden terminal on the West Jersey & Seashore branch, those stations most advanced in construction are at South Camden, Glasboro and Newfield. The third-rail construction has progressed rapidly, the overrunning type of rail being mounted on reconstructed granite insulators. At crossings special jumper cable construction is employed. The cable is laid in bituminized conduit, itself embedded in cement. The cable ends in a bonding terminal by which it is connected to the third rail. A terra-cotta cap completely protects the cable entrance of the conduit from the weather.

The bonding on the 140 miles of track is well in hand. More than two-thirds is completed, this part of the work being done under the handicap of the present operating steam trains. In conjunction with the third rail and track bonding, a double transmission line is being run on a single set of poles. The conductors are arranged on two cross-arms with the three respective three-phase wires on each side of the pole in the usual triangle. A ground wire extends along the top of the pole line.

Current for the transmission circuits will be generated by three 2,000-kilowatt Curtis steam turbines at 6,600 volts, and stepped up to 33,000 volts for transmission. At the substations the rotary converters will deliver direct current to the third rail at 650 volts, with few exceptions the overrunning third rail will be used throughout. In the city of Camden and between Newfield and Millville the overhead trolley will be installed.

It is entirely probable that as this article appears the turbines will be in process of erection at the main station and that a month from now they will be operating the cars over the new line—the longest section of trunk line steam road up to the present electrified.

Fort Wayne Electric Works Type A Transformers.

The Fort Wayne Electric Works, Fort Wayne, Ind., in placing its type A transformer upon the market, has conformed its design and construction to those considerations which long experience has dictated essential for the proper performing of the transforming function.

The company claims that its type A constant-potential transformers have for years given such excellent performance under all conditions of operation that their design and construction must be accepted as particularly adapted to the strenuous service for which they are built.

The type A core consists of punchings of very thin electric sheet steel laid on each other to make the proper thickness. The shape of the punching is such that two laid side by side form the cross-section of the core. Alternate pairs are turned, separating the joints in successive layers.

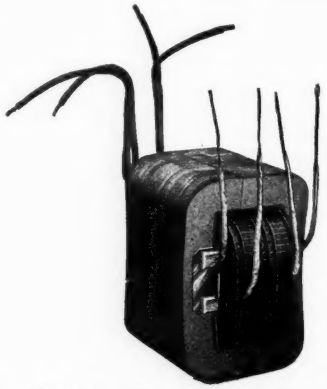
The magnetic circuit thus formed closely encircles both high and low-voltage windings and consists of two branches, one around the upper and one around the lower limb of the coil. The short length of circuit, its uniform proximity to the coil and the special quality of the sheet steel results in a magnetic circuit of extremely low reluctance in the path of practically all the lines of force taking part in the transformation. The form of core, dimensions of circuit and positions of coils result in a maximum efficiency of the magnetic portion of type A transformers. To ensure permanent efficiency the thin magnetic sheet steel laminations are inspected, tested, annealed, assembled and retested before use. The treatment given all steel used in type A cores fixes its magnetic properties and renders it proof against aging or deterioration in service.

The windings or conductors carrying current in a transformer supply to and receive from the coils the energy transmitted to the transformer from the generator and from the transformer to the lamps or motors. The primary coil carries a high-voltage current of small value, the secondary coil carries a low-voltage current of larger value.

The windings of type A coils produced in the past were divided into sections, each section containing a part of the primary and a part of the secondary conductors.

The heavy conductors in the secondary were wound beneath and above the fine wire in the primary so as to shield the latter from mechanical injury.

Marked improvements have recently been made, however, by the engineers of the Fort Wayne Electric Works in the design of type A transformer coils of all capacities. As now designed the coils are made up with two primaries and either two or four secondaries, depending upon the output, each wound upon a wooden form and insulated complete in one unit. By this method, the two sections of the primary coil are wound, taped and subjected to the vacuum treatment with the same care which all our transformer coils have



FIVE-KILOWATT TYPE A TRANSFORMER.

received in the past, the insulation upon the outside of the finished coil being formed in channels to allow free circulation of oil. The sections of the secondary coil are similarly prepared. Thus it will be seen that much better insulation is possible, not only between the primary and secondary coils, but also between the coils and the core.

This construction, in addition to furnishing much higher insulation, also permits the transformer to run at a much lower temperature, due to the fact that

COILS AND CORE COMPLETE.

the surface of the coils in contact with the oil has been greatly increased, together with the circulation of the oil through the ducts formed by the insulating channels.

These coils when in position upon the core form a very compact structure, two of the secondaries being placed in the centre of the core. Upon either side of these secondaries is placed a primary coil and outside of these still another secondary coil. Thus the two primaries are located in a protected position with no chance for mechanical injury.

Since the mean length of a turn has been reduced in this construction, the coils are composed of shorter lengths of copper, thus causing the copper loss to be materially reduced.

An additional advantage in this form of winding lies in the fact that more layers per coil are made possible. By thus increasing the number of layers, the number of turns per layer for a given voltage is decreased and therefore the voltage between layers is reduced. This reduction in the voltage between layers with the same insulation as was used in the old construction guarantees a much higher factor of safety for the new design.

By adopting this careful design the coils operate at a very low temperature without the necessity of any flaring at the ends thus obviating any strain upon the insulation. In thus retaining the regular form of coil the insulation may be made much more perfect, the length of copper in the coil decreased and the operation of installing the new coil greatly simplified.

In winding type A coils only the best of insulating materials are used. The insulation consists of four divisions. The first is the cotton covering of the wire itself which insulates adjacent wires in a layer. The second is the sheet fibre between layers. This is proportioned in thickness according to the voltage between layers. The third division includes the fibre and fabric wrapping around the complete coil. The fourth element is the oil filling all space outside the coil. The last two installations provide a barrier between coils and core.

After winding, type A coils are treated by the vacuum drying and filling process. The coils are sealed in air-tight tanks and the moisture extracted by vaporizing in vacuum at a low temperature. A composition which possesses valuable properties as an insulating cement is then injected into the coils. This composition penetrates and is forced into every pore of the insulating materials in the coil and into all the minute spaces between and around the conductors. Coils treated by this vacuum process possess decided advantages over untreated coils. The composition used is waterproof and prevents absorption of moisture by the coils. It is a plastic cement and prevents injury to the insulation of the conductors by vibration. It is unaffected by the mineral oil or the operating temperatures of type A transformers and is self-heating after puncture by static discharges. It is practically indestructible under ordinary operating conditions and

shows remarkable resistance to deteriorating effects of abnormal conditions.

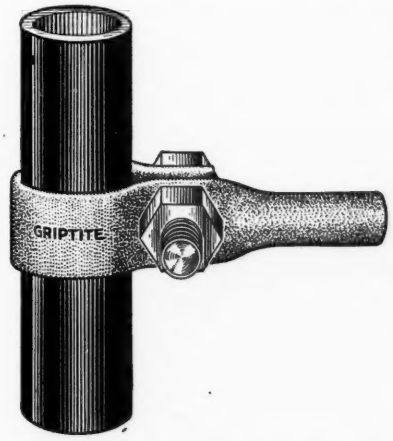
Two primary and four secondary terminal leads pass through sealed porcelain bushings in the case. Four primary coil terminals on a block inside the case permit the use of the transformer on either of two line voltages by connecting primary coils in series or multiple. The same combination of connections with external secondary terminals produces either of two voltages on the secondary line.

All type A transformers are now designed with interchangeable primaries for 1,050 or 2,100 volts. Two complete lines of secondary voltages are furnished, one by winding with ten to one ratio giving 105 or 210 volts and the other by winding secondary for ten per cent higher voltages than with ten to one ratio, giving 115 or 230 volts secondary, or a nine to one ratio. These two lines of transformers may be used for three-wire service. A third line of small sizes (0.6 to 2.5 kilowatts, inclusive) giving 52.5 or 105 volts secondary is also furnished, but is not intended for three-wire service.

Type A transformers are designed for operation on sixty-cycle, 1,050 or 2,100-volt circuits, but will operate equally as well on fifty to 140 cycles and on voltages varying not over ten per cent, from 1,050 or 2,100.

A New Ground Connection Clamp.

The Novelty Electric Company, 50 North Fourth street, Philadelphia, Pa., has placed on the market the "Griptite" ground connection clamp, an illustration of which is shown herewith. The old



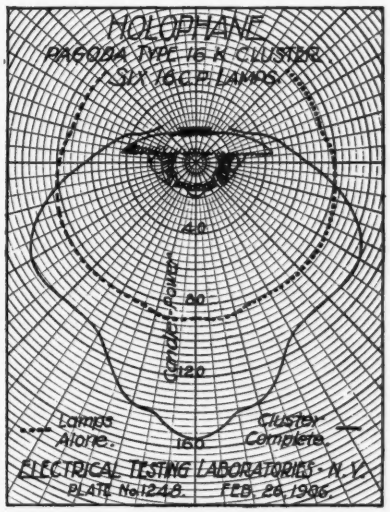
GROUND CONNECTION CLAMP.

method of making a ground between metal conduit and water pipes in buildings wired for an electric lighting system by twisting a piece of copper wire about the pipe, being objected to by the insurance underwriters, and also the objections raised to a two-piece clamp, led the Novelty Electric Company to design this one-piece clamp, which, upon being submitted to the insurance inspectors, it is said, met with instant approval and endorsement.

The clamp is made of a continuous piece of soft copper tube flattened at one end and formed by machinery to exactly fit the various sizes of metal pipe from one-half inch to three inches. The clamp has a hollow tubular end to which a connecting wire may be soldered, and offers a low resistance to the current. The edges are rounded, and when used on lead cables for grounding, do not cut into the lead covering.

The "Pagoda" Reflecting Arc.

The Holophane Glass Company, New York city, announces a very great demand for the "Pagoda" reflecting arc, which has recently been placed upon the market. The

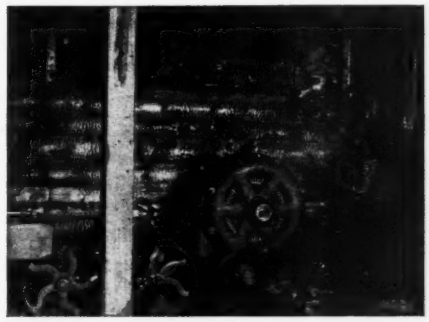


"PAGODA" REFLECTING ARC.

use of small units in this device has led to its being taken in stock by jobbers all over the country. The accompanying illustration shows the distribution curve from the "Pagoda" reflecting arc. The electrical Testing Laboratories, New York city, have recently made a photometric test on the arc, showing the distribution of light from a cluster of six bare lamps and the distribution from the same cluster with lamps equipped with shades used for the "Pagoda" reflecting arc. It will be noted that the light from the arc is practically all below the horizontal and distributed in such a way as to give a very good general illumination.

A Fire Test of an Induction Motor.

The accompanying illustration is instructive as a demonstration of the excellence of modern electrical machinery. It shows a General Electric twenty-horsepower induction motor as it appeared after a fire in the leather warehouse where it was installed by the Salem (Mass.) Elec-



VIEW OF INDUCTION MOTOR AFTER PASSING THROUGH THE FIRE.

tric Lighting Company. After the building and its contents had cooled off sufficiently to be entered, the motor was removed, and after being cleaned and dried and fitted with another pulley, started immediately on application of the current. The motor has since carried its rated load without trouble and does not appear to be damaged in any way except as to appearance. at the time the photograph was taken the armature had been cleaned with compressed air.

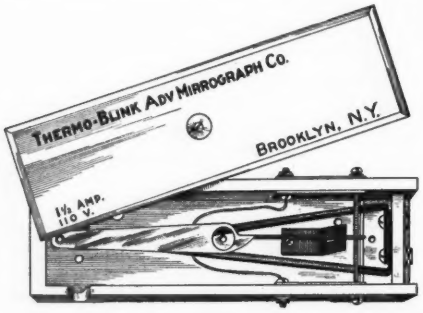
The intensity of the heat to which the motor was subjected is shown by the appearance of the half-burned walls, but still more strikingly by the litter surrounding the motor, consisting of shafting, pulleys, etc., as they fell from the ceiling to the floor. The heat was sufficient to render the paper pulley of the motor useless. The post in the foreground was not in the fire, having been put in place immediately afterward to support the ceiling.

Congresses to be Held at Milan.

The following international congresses will be held at Milan, Italy, during the Exposition which is now being held in that city: September 19-23, Cooperation; date not fixed, Aeronautical; September 2-3, Alpine; September 5-9, Electrobiology and Radiology; September 24-28, Chambers of Commerce; September 23-30, Engineers and Architects; September 17-22, International Union of Tramways and Railways; September 28-29, the Unemployed Question; September 17-21, Commercial Training; date not fixed, Meteorology; date not fixed, Tramway Associations.

A New Thermo-Flasher.

The accompanying illustration shows the latest form of "Thermo-blink," an electrical thermo-flasher made by the Advertising Mirrorgraph Company, 320 Broadway, New York city. This flasher is for two circuits, flashing first one and then the other with regularity. It is constructed so as to do away almost entirely with arcing, the break taking place with a snap. On account of its construction it is impossible for more than one circuit to be lighted at one time, a feature which will be much appreciated by the users of the apparatus. An improvement in this flasher is the method of enclosing it in a porcelain box with a cover, resembling a cutout box. The contacts are of heavy platinum, and will last a long time. All parts of the flasher are replaceable and adjustable, and all the work is done in a first-class manner.



NEW THERMO-FLASHER.

A Four-Wheel Drive Motor Truck.

The accompanying illustration shows an automobile built for heavy service by the Four-Wheel Drive Wagon Company, Milwaukee, Wis. This motor truck has been given extensive tests as to load capacity over all kinds of road, fuel consumption, hill-climbing efficiency and general maintenance, and the maker offers it to the public under a liberal guarantee.

The engine is placed in front in the usual manner of modern auto building, with the engine shaft running lengthwise of the car through the clutch and transmission. The shaft, however, does not engage the rear axle directly, as it does in a two-wheel-driven car, but it terminates in a sprocket just ahead of and above the rear axle. A five-inch Morse silent chain belt connects this sprocket with a sprocket placed on a driving shaft running below the engine shaft from the front to the rear axle. The lower shaft, in turn, by means of bevel gears, drives the shafts located within the hollow axles. In order to give each wheel independent speed when turning corners and traveling over uneven road surfaces, there is placed within each hollow axle a differential or compensating gear in the usual manner of bevel-gear-driven cars; and, in addition to this, there is also placed upon the lower shaft, running from axle to axle, a third differential in order to allow for difference in speed between front and rear wheels.

The bevel gears and pinions are two and three-quarter inches wide, one and one-eighth-inch circular pitch, with involute teeth.

In steering all four wheels, the axles remain in a constant and fixed position under the car, and do not swing or turn. Steering is accomplished by swinging all the wheels upon the vertical pivots by which they are connected to the axles, very much in the same manner as the front wheels of an automobile are steered, except that instead of having a steering knuckle on the inside of the wheel, no steering knuckle is used. The axles terminate in the centre of the wheels, and are connected to the bearing ring of the wheels by means of vertical pins or trunnions. The bearing ring is of much larger diameter than the axles, and is therefore readily swung in any direction about the vertically-placed pins. All wheels steer together from one steering wheel, and track perfectly when rounding a corner.

Although all four wheels are driven, the driving in no way interferes with the steering, each being entirely independent of the other. The wheels are of the disc type, thirty-six inches in diameter, with wooden tires eight inches wide. The company uses a ball bearing of its own design, eleven inches in diameter, and containing forty-eight three-quarter-inch balls. There are two bearings on each wheel, which furnish sufficient carrying capacity, as far as the bearings are concerned, for at least 300,000 pounds—a load ten times greater than the entire machine will ever carry.

The wooden tire is made of seasoned rock elm, sawed into wedge-shaped blocks with the fibre lengthwise, glued and nailed together to form a circle. They are then turned to size, and a shoulder one-half inch wide is formed on each side of the tire, two and one-half inches from the tire surface. A heavy steel ring with a corresponding shoulder is shrunk over the wooden shoulder on each side of the tire, having much the same effect as an ordinary steel wagon tire in holding the wood together and drawing toward the centre. Bolts are run through these rings and the wood blocks from side to side, to prevent the blocks from splitting sidewise.

THE FOUR-WHEEL DRIVE MOTOR TRUCK.

During the recent meeting of the American Institute of Electrical Engineers in Milwaukee one of these trucks was exhibited, the illustration herewith being taken at that time.

The Wireless Telegraph Conference.

It is announced that, on the proposal of the British Government, the International Wireless Telegraph Conference, which is to take place in Berlin this year, has been postponed from June 28 to October 10.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

NEW INDEPENDENT TELEPHONE COMPANY—An independent telephone company is seeking a franchise to install a plant in Omaha, Neb. The incorporators of the company are: J. E. Baum, T. B. McPherson, F. W. Judson, C. J. Green, W. E. Bullard, P. H. Updike, David Cole, H. H. Baldridge, of Omaha, and G. E. Woods, of Lincoln. The company has a capital of $2,000,000.

FIRST ELECTRIC CAR ON PENNSYLVANIA SYSTEM—The first electric car to run over the tracks of the Pennsylvania Railroad arrived at Pittsburg, Pa., on May 28. It made the run from Harrisburg to Altoona, 132 miles, in three hours and forty-six minutes. The run was made as a test, as cars of similar design are being built for the New York, New Haven & Hartford Railroad. The car uses storage batteries.

SOUTHWESTERN TELEPHONE AND TELEGRAPH COMPANY TO EXTEND ITS SYSTEM—The Southwestern Telephone and Telegraph Company, operating in Texas, Arkansas and several other southern states, has filed a certificate with the secretary of state of Arkansas providing for an increase from $5,000,000 to $20,000,000 in its capital stock. This is done with a view to further extension and enlargement of the system in the southwest.

POWER PLANT ON WISCONSIN RIVER—Work will soon begin on the building of a power plant at Grandfather falls, one of the large water powers of the Wisconsin river. The power will be transmitted to Merrill, Mich., and will be used by the Merrill Paper Manufacturing Company. The project is in the hands of L. N. Anderson, John O'Day and other Wisconsin valley capitalists. Grandfather falls is situated on the Wisconsin river at Kilbourn. The fall at this point is about 100 feet.

PHILIPPINE WIRELESS TELEGRAPH STATIONS—Plans have been completed by the Navy Department for the installation of six new wireless telegraph stations in the Philippines. The station to be located farthest north will be at Cape Bojeador, on the extreme northern end of the island of Luzon. Other stations in Luzon will be at San Fernandino and near Sorsogon, in the province of Sorsogon. Another station will be on Romblon Island, the fifth on the island of Cujo, and the station farthest south will be on Sulu Island, probably near the city of Sulu.

LONG TROLLEY LINE—It is announced that the longest through trolley line in the world will soon be inaugurated by the interests controlling the Detroit United, the Rapid Railway, the Detroit, Monroe & Toledo Short Line and the Lake Shore Electric Railway. The new limited service will connect the cities of Cleve- Detroit, Monroe & Toledo Short Line and the Lake Shore Electric to terminal being 238 miles. The first limited connections will be installed between Toledo and Detroit, and will be extended later to Cleveland on the east and to Port Huron on the north.

GEORGIA TROLLEY PROJECT—Atlanta, Macon and Griffin capitalists have made application to the city council of Atlanta, Ga., for a franchise for the Atlanta, Griffin & Macon Electric Railway Company, which will connect these three cities and intervening points. The new line will be one of the longest in the South, and will have a capitalization of about $3,000,000. Application will shortly be made for a charter, and the incorporators declare the line will be in operation in eighteen months. The line will be eighty miles long, and it is proposed to maintain a fast schedule.

TO HARNESS THE WHITE RIVER—A company is being organized to install an electric lighting plant and supply current for Vincennes, Evanston, Princeton, Washington, Mount Carmel, Sullivan and other towns in the vicinity of Vincennes, Ind. Mr. Eugene Rush, of Frankfort, Ind., a capitalist associated with others in what is known as the Michigan Hydraulic Company, is interested in the proposition. A general survey has been made of the White river, and if the proposed enterprise becomes a reality the dam to furnish power and the electric plant will be constructed at Decker, ten miles south of Vincennes. According to Mr. Rush the plant will cost about $638,000, and the work will begin within eight months.

WESTERN TELEPHONE MERGER—At a meeting in Cleveland, Ohio, on May 22, the details of a merger of several of the constituent branches of the Federal Telephone Company were completed. Control of that company's properties passed to a syndicate headed by James S. Brailey, of Toledo, and including Charles A. Otis, A. H. Hough and other Cleveland financiers, as well as a number of financing concerns in Cleveland, Columbus and St. Louis. Mr. Brailey was made president, succeeding Frederick S. Dickson. The Federal Telephone Company is probably the largest of the independent systems, and includes the Cuyahoga Telephone Company, of Cleveland, Ohio, and the United States Telephone Company.

A NEW TEXAS INTERURBAN—A project to build an interurban electric railway between Austin and San Antonio, Tex., is taking form. A. S. Reese, of New York, has applied for information regarding government restrictions involved in the building of such a system. It is announced that the line between Austin and San Antonio will be bonded for $3,000,000. While the details for building the system have not been made public, it is stated that they contemplate the construction of a line to reach from Llano on the north to San Antonio on the south, with approximately 200 miles of track. The central power station will probably be located at Marble Falls, where water-power is available for generating current.

INTERSTATE TROLLEY PROJECT—Preliminary steps have been taken toward the construction of an interstate trolley line between Canaan, Ct., and Great Barrington, Mass. The Consolidated Railway Company has directed its corps of engineers to make surveys for a street railway running from Great Barrington south through Sheffield and Ashley Falls to the Connecticut boundary. If the road is built it will be an extension of the Berkshire line. It will probably operate in conjunction with the Canaan & Berkshire Tramway Company, which holds a franchise to build a street railway south from the Massachusetts border. The incorporators are: Samuel A. Eddy and J. Henry Roraback, of North Canaan, and H. Dwight Sisson, of New Marlboro, Mass.

ERIE ELECTRIFICATION PLAN—It has been announced that the directors of the Erie Railroad have authorized the immediate electrification of that portion of the line between Rochester and Mount Morris, N. Y., a distance of thirty-five miles. It is probable that before this work is completed a connection of eight miles will be made to Conesus lake. This will be gradually extended until the entire Rochester division is so equipped. The current will be obtained from one of the companies now operating at Niagara Falls. The company has recently made a utility test of a Union Pacific motor passenger car. It has been decided to give the car a service test. For this purpose it will be put in regular service between Newburgh, Greycourt and Turners, making connections with main line trains.

MORE POWER FOR THE COEUR D'ALENE—Work has begun on a $2,000,000 electric plant at Thomson's Falls, on Clark's fork, in Montana. It is expected that the Coeur d'Alene district will shortly receive service from the transmission lines. Riparian rights and land along the Clark's fork at Thomson's Falls have been secured. Work has been started on the construction of a flume three-quarters of a mile long, which will convey the water around the falls. There is a possible development of 37,000 horse-power, entailing an expenditure of $2,000,000. For the present the company is going ahead with the development of 10,000 horse-power. Clark's fork is a stream near Missoula, Mont. The stream empties into Lake Pend D'Oreille, east of Hope, Ida. The transmission line will be about thirty miles long.

TO BUILD A POWER PLANT ON THE MISSISSIPPI—It is announced that the work of constructing the second largest bar-

rage in the world will be begun this year at the foot of the Des Moines rapids of the Mississippi river opposite Keokuk, Iowa. It has been figured that a dam from thirty to thirty-five feet high will furnish more than 100,000 horse-power. The project is in charge of the Keokuk & Hamilton Water Power Company. In February, 1905, congress gave the concern permission to build the dam, and it is said that arrangements have been made to raise part of the $6,000,000 the project will require. The company plans to sell power to factories and other concerns. The work, as planned, will consist of a stone dam reenforced by steel directly crossing the river. At the Iowa terminus of the dam the electrical plant will be located. At the Iowa end there will also be a large lock for the passage of steamers.

EXTENSIVE SUBWAY SYSTEM FOR THE NEW YORK & PENNSYLVANIA TELEPHONE AND TELEGRAPH COMPANY—The New York & Pennsylvania Telephone and Telegraph Company has under way a plan to construct subways to cost $900,000, and put under ground practically all of the wires in its territory. A petition asking permission to construct such a system has been presented to the common council. It is the desire of the company to enter buildings under ground, and, where rights can be secured from property owners in residential sections, it will locate distributing poles, one to each block, from which the subway wires will run to various houses. The company offers to furnish bonds to any amount that it will place the subway and complete the work in three years, and that it will allow space for fire-alarm, police telegraph and telephone service for the city. It also agrees to complete all work ahead of the proposed paving.

MONTREAL LIGHT, HEAT AND POWER COMPANY'S REPORT—The report of President Holt, of the Montreal Light, Heat and Power Company, announces that the increased demand for power has caused the directors to decide to develop during the present season the power of the surplus water of the Soulanges canal. The power plant, when completed, will have an output of approximately 15,000 horse-power. The directors have appropriated $251,818 of the year's surplus to provide for renewals and depreciation, and $50,000 for the insurance fund. During the year $396,000 of the company's four and one-half per cent bonds were issued. Of this amount, $358,000 was used to repay the company seventy-five per cent of the amount expended for extensions in the gas and electric departments, and $38,000 was used for the retirement of a like amount of the debentures of the Royal Electric Company. There were also issued $64,000 of the company's five per cent bonds to retire the balance of the outstanding bonds of the Standard Light, Heat and Power Company. In the electrical department the report shows 39,448 incandescent lamps connected, 112 arc lamps, 180 street lamps connected and 6,386 horse-power connected in motors. The total assets were $27,437,733.

PERSONAL MENTION.

MR. W. A. CLEMENT has tendered his resignation as manager of the Oswego (N. Y.) exchange of the Ontario Telephone Company.

MR. C. H. EDWARDS, who for the past six years has been connected with the Fargo (N. D.) branch of the Northwestern Telephone Company, has been appointed manager of the St. Paul (Minn.) exchange.

MR. L. LEBARON, for fifteen years in the employ of the Western Union Telegraph Company, has resigned as manager of the Pensacola, Fla., office. A. F. Cason, of Dothan, Ala., has been named as Mr. LeBaron's successor.

MR. F. B. PERKINS, Toledo, Ohio, has been elected vice-president and treasurer of the Toledo & Chicago Interurban, and president of the Kendallville & Goshen Traction Company. The latter is to be an extension of the Toledo & Chicago Interurban Company, connecting it with the line into Chicago.

MR. H. S. KERBY, manager of the Cumberland Telephone and Telegraph Company at Henderson, Ky., has been appointed assistant manager of the Evansville, Ky., district. This district comprises some sixty exchanges, including Henderson, Owensboro, Madisonville, Providence, Hopkinsville and Princeton.

MR. FREDERICK C. R. SPENCE has severed his connection with the Stanley Instrument Company, Great Barrington, Mass., and is now with the Fort Wayne Electric Works, Fort Wayne, Indiana. His headquarters are at Fort Wayne, Indiana, and he is acting in the capacity of a special representative for the sale of meters, in which line of business the above company has a large and increasing trade.

MR. E. W. ROCKAFELLOW, who has been identified with the selling organization of the Western Electric Company since 1884, has recently been appointed sales manager of the supply department. Mr. Rockafellow is one of the most widely known men in the electrical industry, and this action on the part of the management of the Western Electric Company will be pleasant news to Mr. Rockafellow's large circle of friends.

MR. S. O. OCHS, who was formerly associated with the Stanley Instrument Company, Great Barrington, Mass., is now representing the Fort Wayne Electric Works, Fort Wayne, Indiana, in its New England territory with headquarters at Boston. He is well known to the electrical fraternity throughout the New England states, including New York. Mr. Ochs has just suffered a severe bereavement in the loss of his sister, who died in Kansas City recently.

MR. ERNST KOERTING, the noted European engineer, was accorded the honorary degree of doctor of engineering at the celebration of the seventy-fifth anniversary of the Koeniglich Preussische Technische Hochschule, of Hanover, Germany, for his scientific researches and discoveries in gas engines and other important branches of engineering. Dr. Koerting lives in Pegli, Italy. He is a member of the well-known firm of Gebr. Koerting Aktien-Gesellschaft, Koertingdorf, Hanover, and is interested in a number of large enterprises in the United States, among them the De La Vergne Machine Company, of New York, and the Schutte-Koerting Company, Philadelphia, Pa. Dr. Koerting is at present sojourning in this country.

EDUCATIONAL.

COMMENCEMENT EXERCISES AT STEVENS INSTITUTE OF TECHNOLOGY—The thirty-fourth annual commencement exercises of the Stevens Institute of Technology, Hoboken, N. J., will be held Thursday morning, June 14, at 10.30 o'clock, in the auditorium of the institute. The dedication exercises of the Morton Memorial School of Chemistry will be held the preceding day at 2 P. M.

COMMENCEMENT WEEK AT WORCESTER POLYTECHNIC INSTITUTE—On Sunday, June 10, at 7.30 P. M., the baccalaureate sermon will be preached by the Rev. Willard Scott in Central Church, Institute road. On Tuesday, June 12, at 8 P. M., the annual commencement lecture will be given by Dr. L. P. Kinnicut. The subject will be "Sanitary Science and the Public Health." On Wednesday, June 13, at 3 P. M., a demonstration will be given of the four-stage centrifugal pump at the hydraulic testing plant. From 8 to 10 P. M the president's reception to the alumni and senior class will be held. On Thursday, June 14, at 10.30 A. M., the graduating exercises will be held in the assembly room, Boynton Hall. The commencement address will be made by Charles G. Washburn, the subject of which will be "Technical Education in Relation to Industrial Development." At 1 P. M. the alumni dinner will be held at the institute, followed by the annual meeting of the Alumni Association.

COMMENCEMENT WEEK AT LEHIGH UNIVERSITY—Commencement week will be held at Lehigh University, South Bethlehem, Pa., from June 10 to June 13. On June 10, at 11 A. M., the baccalaureate sermon will be delivered by the Right Rev. Leighton Coleman, bishop of Delaware. On Monday, June 11, the class exercises will be held in the park at 2 P. M. The Lacrosse game between the alumni and Lehigh will be held on the university athletic grounds at 4 P. M. The junior hop will be conducted in the gymnasium at 9 P. M. On Tuesday, June 12, the annual meeting of the Alumni Association will be held at 11.30 A. M., with the alumni luncheon at 1 P. M. The baseball game between the Indians and Lehigh will be held on the university athletic grounds at 3.30 P. M. The Phi Beta Kappa address will be made by Charles Sprague Smith, in the Packer Memorial Church, at 8 P. M. The president's reception will be held in the gymnasium at 9 P. M. On Wednesday, June 13, commencement exercises will be held in Packer Memorial Church at 10.30 A. M.

OBITUARY NOTICE.

WILLIAM THOMAS BOUCHELLE, who died at his home in Greenwich, Ct., on May 19, was one of the pioneer telephone men of the country. He entered the service of the old Metropolitan Telephone and Telegraph Company, of New York city, over twenty-two years ago, and in the period that followed witnessed at close range the development of the greatest system of communication the world has ever known. His was an active part in this remarkable enterprise, and the presence of so many men at the funeral services, representing, as they did, such wide interest, testified to the high position in which he was held. As a mark of respect to his memory, the executive offices of the New York Telephone Company were closed from one o'clock on the afternoon of the day of the funeral, which was held at the family residence in Greenwich, following the arrival of the 3.26 train from New York city. William Thomas Bouchelle was born in Baltimore, Md., on January 22, 1848, and was the son of Peter Augustus and Sarah Ellen Bouchelle. He came to New York in the year 1869, and entered the employ of Dodd's Express (now the New York Transfer Company) holding a responsible position with that company up to 1883. In the year of 1876 he married Mary Ennis Woodruff, daughter of Augustus and Ann Eliza Woodruff, of New York, a faithful and devoted wife, who now survives him. It was not until 1884 that Mr. Bouchelle entered the services of the New York Telephone Company (then the Metropolitan Telephone and Telegraph Company), and for more than twenty-two years after that he devoted himself efficiently and loyally to the company's interest. For seventeen years he was connected with the executive office as confidential secretary and assistant to the president. His distinguished characteristics, unselfish fidelity and amiability gave great value to his work, and won for him a very large circle of friends. His business connections placed him in many responsible positions. In addition to the position he held with the New York Telephone Company he was treasurer of the Empire City Subway Company, as well as a director of that company. He was also a director of the American District Telegraph Company, the Holmes Electric Protective Company and the Northeastern Telephone and Telegraph Company. His unfailing good nature and geniality was a rare gift. He was a member of the New York Athletic Club, the Fairfield County Golf Club, the Indian Harbor Yacht Club, as well as the Masonic, Royal Arcanum and other fraternal orders. Mr. Bouchelle was attentive to his duties, however, up to within a few days of his death. Although unknown to most of his friends he had suffered for over a year from ulceration of the stomach, and while he was known to be far from well his death was sudden and unexpected, the stricken man being conscious up to the end and recognizing those around him. Dr. L. P. Jones, of Greenwich, attended him in his last hours. The wide popularity of the man made the funeral necessarily large. It was set for May 22, and the house was cleared so that as much space as possible would be made for the friends and business acquaintances who would attend. Upon the arrival of the 3.26 train from New York the mourners and friends were conveyed to the home where the Rev. George Thompson, rector of Christ Church, Greenwich, conducted the services, and a quartette from the same church sang several selections. The service was beautiful as it was impressive. Floral tributes filled the room and were banked around the supports of the catafalque. Particularly handsome pieces were noticed from the New Telephone Company, the Fairfield County Golf Club, the Holmes Electric Protective Company, the Empire City Subway Company and the New York Transfer Company. The burial took place on Wednesday morning at Trinity Cemetery, 152d street and Amsterdam avenue, the committal service being conducted by the Rev. George Thompson. The pall bearers were Charles T. Wills, James McCutcheon, George P. Sheldon, F. W. Ritter, C. E. Wilson, F. P. Marsh, Otis H. Cutler, James B. Curtis, John H. Cahill and Walter Brown. Among the prominent telephone men and other New York friends present at the funeral services were the following: Charles F. Cutler, U. N. Bethell, John H. Cahill, Walter Brown, Ford Huntington, H. F. Thurber, J. C. Reilly, H. S. Snow, Waldron Hoppins, Alexander Cameron, J. L. Hamar, A. R. Pardington, E. F. Sherwood, C. R. Bangs, J. C. Vail, B. Gherardi, Charles Kingsley, D. C. Cox, G. C. Allen, J. S. McCulloh, James A. Stewart, E. A. Gurnee, W. F. Farquhar, Lincoln Jones, James Robb, J. C. Frey, Thomas D. Bowen, W. Sefton, A. Middleton, E. Hoosey, A. L. Snow, Otis H. Cutler, E. H. Fallows, H. C. Knox, Peter Ferrier, E. A. Sergeant, E. C. Mitchell, H. C. Vance, H. G. McCully, C. I. Walker, S. H. Starrett, H. S. Black, J. E. McDonald, Colonel H. S. Kearney and J. M. Ferry. The Greenwich people attended the funeral services in large numbers.

WILLIAM THOMAS BOUCHELLE.

ELECTRICAL SECURITIES.

Trading in stocks during the past week dropped to the lowest ebb of the year. Public interest and participation in the market has dwindled steadily, until it is hard to recognize any commission business whatever. The market has, however, attained a very favorable position, considering the reaction which has taken place since the San Francisco disaster. There is an apparent coherence of action among all sorts of financial interests, and while the market might technically be termed a waiting market, there is little danger of any pronounced decline. The present indications of a bumper crop are strengthening the opinion that the agricultural contingent will be represented very strongly in speculative fields in the near future. The announcement of the government's intention to stop the present system of lending government deposits to the national banks indicates that the recent shortage of gold is over. The extensive shipments of gold from San Francisco to this city have also brought about an easier monetary condition.

ELECTRICAL SECURITIES FOR THE WEEK ENDING JUNE 2.

New York:	*Closing.*
Allis-Chalmers common	23⅜
Allis-Chalmers preferred	60
Brooklyn Rapid Transit	82⅞
Consolidated Gas	139½
General Electric	169¼
Interborough-Metropolitan common	51½
Interborough-Metropolitan preferred	85¼
Kings County Electric	165
Mackay Companies (Postal Telegraph and Cables) common	75¾
Mackay Companies (Postal Telegraph and Cables) preferred	73½
Manhattan Elevated	152½
Metropolitan Street Railway	114
New York & New Jersey Telephone	140
Western Union	92½
Westinghouse Manufacturing Company	156

Boston:	*Closing.*
American Telephone and Telegraph	137¾
Edison Electric Illuminating	246
Massachusetts Electric	69
New England Telephone	137
Western Telephone and Telegraph preferred	90

Philadelphia:	*Closing.*
Electric Company of America	11⅜
Electric Storage Battery common	72
Electric Storage Battery preferred	72
Philadelphia Electric	7⅞
Philadelphia Rapid Transit	26½
United Gas Improvement	84¾

Chicago:	*Closing.*
Chicago Telephone	120
Chicago Edison Light	147
Metropolitan Elevated preferred	67
National Carbon common	89
National Carbon preferred	120
Union Traction common	4¾
Union Traction preferred	13

The regular quarterly dividend of 1 per cent on the South Side Elevated is payable June 30. Books close June 19 and reopen July 2. The South Side Elevated May daily average of passenger traffic was 97,159, an increase of 7,188 fares.

The daily average of passengers carried by Northwestern Elevated for May was 81,748, increase 3,885; by the Metropolitan Elevated 136,735, increase 11,571 per day.

ELECTRIC LIGHTING.

HIGHLAND, N. Y.—Highland will be wired for electric street lights.

ATHOL, MASS.—Athol has voted to install a municipal electric light plant, and has appropriated $15,000 for the purpose.

CHICAGO, ILL.—At the annual meeting of the directors of the Commonwealth Electric Company the full list of directors was re-elected.

HERSEY, MICH.—The Hersey village council has voted to have electric lights, and has made arrangements with F. McIntyre to supply them for $30 per light per year.

MARINE CITY, MICH.—The Edison Electric Light Company, of Detroit, has been given a franchise for thirty years and a contract for ten years for lighting the city.

INDIANAPOLIS, IND.—The town council of Sheridan is preparing to ask for bids for the erection and installation of an electric light plant. W. M. Robbins is superintendent.

INDIANAPOLIS, IND.—The Decatur city council contemplates installing a series alternating-current street lighting system in the municipal light plant. W. J. Malott is superintendent.

MONTPELIER, VT.—Walker & Gallison, engineers, are at work at the Bolton Falls plant of the Consolidated Lighting Company. They are establishing levels preparatory to the installation of much new apparatus.

GADSDEN, ALA.—At a meeting of the Gadsden city council a lighting franchise was granted to the Alabama City, Attalla & Gadsden Railway Company for fifteen years. The company is required to build a plant at a cost of $90,000.

CLEVELAND, OHIO—The Cleveland Electric Illuminating Company will erect a new power station on West Twenty-eighth street. The building will be of brick, sixty-four by ninety-four feet. The general contract has been awarded to John Gill & Sons.

ST. CHARLES, MO.—The St. Charles city council has granted a twenty-year electric light franchise. The company which secured the franchise is composed of Walter S. Ashton, Edgar C. Parker, George T. Mathews and Victor H. Becker, Jr., of St. Louis.

HAZLETON, PA.—At the annual meeting of the directors of the Hazleton Electric Light and Power Company it was decided to make extensive additions to the local plant. The company has acquired the plant of the Lehigh Traction Company and will install additional engines.

MASON CITY, ILL.—Mason City is soon to have a municipal electric lighting plant. A bond issue will be provided for and a plant erected, costing in the neighborhood of $10,000. The city council has been at work for some time, and the work will be rapidly pushed forward to completion.

MILWAUKEE, WIS.—The new Milwaukee lighting commission will ask for new proposals to sell the city a site for an electric light plant. The commission has organized with I. B. Cary as president and Fred Landeck, secretary. There is $60,000 in the hands of the commission for the purchase of a site.

RICHMOND, VA.—The Emporia light and power plant and ice factory, located in Belfield, has been destroyed by fire, entailing a loss of $25,000. The plant has been operated by the Richmond Engineering Company, of which Andrew Pizzini, of Richmond, is the head. The property was fully insured and will be rebuilt at once.

HATTIESBURG, MISS.—A movement is well under way to form a combination of the electric lighting and power plants of Hattiesburg and three towns to the north, with a view to utilizing the power for the operation of an interurban electric road that will connect Hattiesburg and Laurel, running through East Abuchie and Ellesville.

COLORADO SPRINGS, COL.—Arrangements are being made at Green Mountain Falls by Theophilus Harrison and F. E. Dow for the installation of a power plant which will be utilized for lighting purposes in that town this fall. The plant will be placed on the townsite of Green Mountain Falls, at a point where there is a fall of nearly 1,000 feet, within a distance of 2,200 feet from reservoir No. 2, belonging to the Green Mountain Falls system.

OKLAHOMA, OKLA.—At a meeting of the Oklahoma city council an ordinance was acted upon and passed by that body granting the Oklahoma Electric Light and Power Company a new franchise. This ordinance provides for the reduction of the price of electric current to ten cents per kilowatt-hour, which is one-third less than the rate heretofore charged.

PAW PAW, MICH.—The council of Paw Paw has been considering for some time the feasibility of building a dam about one and one-half miles north on the Paw Paw river in order to secure greater power for the municipal electric lighting plant, and at the same time furnish sufficient power for the water-pumping station. The lake thus formed, it is estimated, will cover 800 acres.

LEWISTON, ME.—Libbey & Dingley, of Lewiston, have bought the controlling interest in the Mechanic Falls Water, Electric Light and Power Company, from H. C. Rowell, of Berlin, president of the company. In addition to this Libbey & Dingley bought other stock, thus securing a majority of the stock. This company has been in operation about ten years, and has an investment of $70,000. It owns a water power which produces about 250 horse-power under average conditions.

GREENVILLE, MISS.—The stockholders of the Delta Electric Light, Power and Manufacturing Company held their annual meeting recently, and several changes in the directorate were made. The new directors are as follows: W. E. Hunt, James Robertshaw, Henry Crittenden, E. J. Lenz and M. B. Carson. Following the election of the directors the board met and elected W. E. Hunt, president; James Robertshaw, vice-president; Henry Crittenden, secretary, treasurer and general manager, and E. J. Lenz, superintendent.

MONTREAL, CANADA—For the year ended April 30 last, the Montreal Light, Heat and Power Company showed an improvement of $284,839 in gross earnings over the preceding twelve months, while the net earnings increased $155,763, or about ten per cent. It was the most prosperous year in the history of the organization. Surplus for the year increased $150,000, and now stands at $598,486. The company earned for the year, not taking into consideration any appropriations for special purposes, approximately 7.5 per cent on its $17,000,000 of stock.

JACKSON, MICH.—The Thornapple Electric Company, which has its principal office at Hastings, but is largely owned at Grand Rapids, has changed its name to the Thornapple Gas and Electric Company. There will be no change in the conduct of the business, which is the furnishing of electricity to Lake Odessa, Nashville, Middleville and Hastings. The company is now engaged in putting in another wheel at its dam at La Barge. This will be ready for service shortly, and will represent an investment of $20,000. The present horse-power is 500, and the new wheel will double this.

JAMESTOWN, N. Y.—Announcement has been made that Governor Higgins has signed the charter amendment of Jamestown, placing the municipal light plant in the control of a commission. The amendment was passed by the legislature last winter and recently was approved by the council. By the terms of this bill a commission of four members is created, who with the mayor, as a member *ex officio*, will assume sole control of the plant. The members will be appointed for one, two, three and four years, respectively. The term of office for future appointments will be four years. The appointments are made by the mayor, subject to the approval of the council.

HARRINGTON, DEL.—Last August a franchise from the town of Harrington, Del., was secured for an electric light plant by W. J. Peall. The power-house will be thirty by seventy feet, of concrete construction, and the plant, when fully completed, will cost in the neighborhood of $40,000. The equipment will include two 125-brake-horse-power Berger producer-gas engines; two seventy-five-kilowatt, two-phase, alternating-current Fort Wayne generators; operating at 220 volts, for Nernst lamp and incandescent lighting. The plant will be large enough to furnish day power as well as to run a twenty-ton ice plant, which will be erected during the fall. Harrington is a town of some 5,000 inhabitants, and the management is determined to make this plant represent a permanent investment in every way. The plant will be constructed by the Peall-Klier Construction Company, Incorporated, of Wilmington, Del. No expense will be spared either in the pole line, line work or mechanical equipment.

ELECTRIC RAILWAYS.

NASHUA, N. H.—Work is being pushed on the new Goff's Falls, Litchfield & Hudson electric railway.

DETROIT, MICH.—A new electric line between Romeo and Almont is being projected by Robert Oakman.

NEWPORT BEACH, CAL.—Extensive plans for the improvement of its service are being made by the Pacific Electric Company. The line is being extended beyond East Newport to the bay.

FAIRFIELD, IOWA—The meeting at the Jefferson county club rooms for the purpose of discussing the feasibility of an interurban road was well attended, and after a general discussion a committee of fifteen were selected to solicit $30,000 of preferred stock.

BUFFALO, N. Y.—The Buffalo Southern, an interurban line running out of Buffalo, has been sold to Chicago interests said to be represented by A. C. Mather, of that city. H. Tracy Rogers, H. C. Lein and Daniel Wallin, of Buffalo, are among the directors who sold their holdings.

OROVILLE, CAL.—Construction work has been started on the Sutter county extension of the Northern electric road. The roadbed will be completed by September next, and cars will be running over the line before the close of the year. There are no cuts nor bridges, and construction work will be simple.

ST. JOSEPH, MICH.—The South Bend & Southern Michigan line has been placed in operation. This road, connecting Elkhart, Goshen and South Bend with St. Joseph, has been under construction from South Bend to St. Joseph for over a year. The construction of Michigan division represents an investment of $750,000.

NORFOLK, VA.—Plans for the new power-house of the Norfolk Railway and Light Company are being prepared. The plant will be located on the site of the old Anderson mill, and will cost complete nearly $1,000,000. The building alone, which will be of brick, will cost $100,000, and more than $800,000 worth of machinery will be installed.

LEXINGTON, OKLA.—The Oklahoma City, Lexington & Sulphur Springs Electric Railway Company at its annual stockholders' and directors' meeting elected the following board: Jay Sherman, J. S. Little, E. J. Keller, Robert E. Thacker and H. A. Hawk, all of Lexington, Okla.; E. P. Speers, of Dallas, Tex., and W. S. Upp, of Shawnee, Okla. At the directors' meeting the following officers were elected: Jay Sherman, president; E. J. Keller, vice-president; George A. Teague, secretary; H. A. Hawk, treasurer.

SCRANTON, PA.—The Northern Electric Railway Company is pushing the construction of its road through the northern part of the county, and has placed an order for 900 tons of rails, to be delivered before October 1 next. The company now has a continuous line to Leggett's Gap and options have been closed which give it a private right of way from Scranton to Dalton. The company proposes, eventually, to extend its line to Factoryville, and to run a spur to Waverly. The route is now being graded as far as Clark's Summit.

INDIANAPOLIS, IND.—Incorporation papers of the Kendallville & Goshen Traction Company, of Kendallville, with a capital of $10,000, have been filed. The directors are: F. B. Perkins, A. B. Shepard, F. L. Wellsheimer, T. A. Redmond and William Robbins. The line is to run from Kendallville through Albion, Ligonier, Rome City, Wawaka, Millersburg, Wolcottville, La Grange and Syracuse. The same directors have incorporated a light and power company with $25,000 capital, for the purpose of furnishing heat and light to the above towns and also Avilla, Auburn, Garrett, Butler and Waterloo.

CHARLESTOWN, W. VA.—The city council of Martinsburg has voted to grant the right to construct a trolley line with the understanding that a bond for $10,000 shall be given for the faithful performance of the contract. Steps will be taken immediately to organize the company. The prospect of a street car line in Martinsburg and connection with neighboring towns is bright. The first objective point will be Shepherdstown, and from there to Harper's Ferry and Charlestown. The purpose is to construct the line through the most populous and productive portions of Berkeley and Jefferson counties. In time it is expected to connect Gerardstown and Hedgesville with Martinsburg.

TELEPHONE AND TELEGRAPH.

CHICO, CAL.—The Sunset Telephone Company is installing a conduit system in Chico.

PITTSBURG, PA.—The Central District and Printing Telegraph Company will erect a new building at Bellevue.

CHESTER, PA.—The Bell Telephone Company has awarded the contract for the construction of a new exchange building.

KINGSLAND, N. J.—The New York & New Jersey Telephone Company has begun the extension of its system in Kingsland.

BROXTON, GA.—The Broxton Telephone Exchange has passed into new hands, and a great many improvements are being made in the service.

ARCADE, N. Y.—The Bell Telephone Company has purchased the stock of the Wyoming & Cattaraugus Telephone Company. George M. Feeney will act as local manager.

ST. LOUIS, MO.—The Suburban Telephone Company has been granted permission to erect its poles in Webster Groves. It is said the new company will connect with the Kinloch system.

KINGSTON, N. Y.—The Griffin Corners Telephone Company and the Rose Telephone Company have arranged to connect their systems at Halcottville. This will give Kelly Corners, Halcottville and Roxbury direct connection with Kingston and New York.

PHILADELPHIA, PA.—J. F. Stuckert has been awarded the contract for the $14,000 telephone station to be erected at Media for the Bell Telephone Company. The building will be twenty-six by fifty-seven feet, two stories high, of brick with stone trimmings.

KNOXVILLE, IOWA—The Plymouth Farmers' Mutual Telephone Company has incorporated under the laws of Iowa, with its principal place of business at McMillan schoolhouse, Clay township, Marion county, Iowa, and with the postoffice address of Durham, Iowa.

RUTLAND, VT.—A construction gang is in Manchester stringing 7,480 feet of thirty-pair cable. The purpose is to do away with the overcrowding of telephone poles and wires. There has been a substantial growth in the telephone business in Manchester in the last few months.

TECUMSEH, NEB.—The Johnson County Home Telephone Company has purchased the lines of the Johnson County Telephone Company, owned by H. F. Canon, of Cook. The lines include local exchanges at Cook and Graf as well as a line from Cook to Tecumseh. The acquisition gives the independent company about 400 additional telephones. Mr. Canon will be retained as manager, and the transfer of ownership will be made July 1.

BARBERTON, OHIO—The Barberton Telephone Company has been organized and has taken over the property of the Central Union company at Barberton. The new company is capitalized at $30,000, a large part of which is held in Barberton. The directors are: A. R. Henry, James McNamara, C. Weigand, George Shaw and Tim O'Toole, of Barberton; E. A. Reed, of Columbus, and F. G. McConnell, of Akron. F. G. McConnell, who is mentioned among the directors, is district manager of the Central Union Telephone Company. He was formerly manager of the Youngstown exchange.

BUTTE, MONT.—The Montana Independent Telephone Company, which is preparing to install a new sytem in Butte and elsewhere in Montana, will introduce a number of innovations which have proved popular in Utah, where a similar company has been established for several years. The directors of the new company are: A. J. Davis, Harry Gallwey, Charles J. Kelly, Cornelius F. Kelley, M. Sellers Largey, T. S. Lane and H. B. Brown, of Butte; P. B. Moss, of Billings, Elmer B. Jones, of the Utah Independent company, and George T. Odell, of Salt Lake. The company has a capital stock of $1,500,000.

NEW MANUFACTURING COMPANIES.

SPRINGFIELD, MASS.—The Alton Manufacturing Company, of New York, has been incorporated at the secretary of state's office with a capital of $1,500,000, to manufacture lighting and heating apparatus. The directors include C. F. King, of Boston.

BATON ROUGE, LA.—Articles of incorporation have been filed for the Watson Electric Supply Company, domiciled at Shreveport. The capital stock is $5,000 and the officers are S. M. Watson, president; W. C. Evans, vice-president; W. W. Jones, secretary and treasurer.

INDUSTRIAL ITEMS.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., in bulletin No. 3,703, describes and illustrates a line of direct-current motor-driven laboratory lathes.

THE STANLEY-G. I. ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., has ready for distribution bulletin No. 607, describing and illustrating "G. I" hanger boards for multiple arc lamps.

THE W. S. HILL ELECTRIC COMPANY, New Bedford, Mass., has in preparation an elaborate catalogue showing a very handsome line of electrical supplies. This catalogue may be had upon request.

THE ADVERTISING MIRRORGRAPH COMPANY, Brooklyn, N. Y., will be pleased to send its new descriptive matter relating to the "Thermo-Blink" automatic motorless flashers. This flasher is made for both direct and alternating-current circuits.

THE DONGAN INSTRUMENT COMPANY, 110 State street, Albany, N. Y., advises that it will be ready for the fall trade with a new line of wattmeters and portables, and a new design for alternating-current and direct-current volt and ammeters.

THE WESTERN ELECTRIC COMPANY, New York city, announces its new city sales department, 19 Murray street, and its new stock warehouse, at Bank and Washington streets. The new supply stock warehouse affords sixty thousand square feet of floor space, which will be devoted exclusively to electrical supplies.

G. M. GEST, New York and Cincinnati, has closed a contract, through his New York office, for the construction of 500,000 feet of conduit for the Toronto Railway Company, Toronto, Ontario. This will complete the subway system for that company, and will give it one of the most complete underground conduit systems of any railroad.

THE HOLTZER-CABOT ELECTRIC COMPANY, Brookline, Mass., is making an important announcement to jewelers, silversmiths and metal workers, concerning electric lathe motors. The company is making a special offer of a motor on trial. Full information and application blanks will be sent to any interested upon request.

THE COOPER HEWITT ELECTRIC COMPANY, New York city, in bulletin No. 12 describes and illustrates the Cooper Hewitt mercury vapor lamp for direct-current and alternating-current circuits. In addition to the text, this bulletin gives a number of fine illustrations showing the adaptation of Cooper Hewitt lamps to various industrial services.

GILLETTE, VEBBER & COMPANY, New London, Ct., are calling attention to the "G. V." pipe cap for covering the outdoor end of service pipe. This pipe cap can be used on pipe with or without threads, is galvanized, uses brass screws and can be used for any number of wires, including a cable. Descriptive data will be furnished on request.

THE SPRAGUE ELECTRIC COMPANY, 527-531 West Thirty-fourth street, New York city, is distributing a handy little instruction book concerning the installation of "Greenfield" flexible steel conduit and armored conductors. In addition to the literature of the subject the book contains several pages of engineering data of considerable interest.

THE ROBINS CONVEYING BELT COMPANY, Park Row Building, New York city, in bulletin No. 15 describes and illustrates Robins conveying and lifting machinery in retail coal pockets and locomotive coaling stations. This bulletin is very interesting, and gives a lot of valuable information concerning industrial operations of this nature. It may be secured upon request.

THE DE LA VERGNE MACHINE COMPANY, New York city, has issued a new eighty-two-page catalogue, describing the mode of operation of the "Hornsby-Akroyd" oil engine, and giving illustrations and short descriptions of the more recent installations of these engines. It is stated that over 14,000 are now in use. The cost of power is extremely low, being from one-quarter to one-half cent per brake-horse-power-hour.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, Rochester, N. Y., reports having closed contracts for switchboards for the following places: Exeter, Nebr.; Portsmouth, N. H.; Bedford, Ind.; Hartford, Ct.; Rochester, N. Y. Also a 3,000-line multiple board for the People's Home Telephone Company, Morgantown, W. Va., and one for the Marietta Home Telephone Company, Marietta, Ohio.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., has sold to the Roanoke Rapids Power Company, Roanoke Rapids, N. C., a 750-kilowatt, 2,300-volt, 200-revolutions-per-minute, alternating-current generator, to be installed at the company's generating plant at Roanoke Rapids. In addition to the above the company also reports having sold a fifty-kilowatt, 2,300-volt, belt-type alternator to the Pea River Power Company, of Elba, Ala., to be driven by water power. The New York navy yard, Brooklyn, N. Y., has recently purchased from the Crocker-Wheeler Company a motor-generator, to be used in connection with its wireless telegraph equipment.

DODGE & DAY, engineers, Philadelphia, Pa., have completed plans for the new works of the Arthur Koppel Company, of New York and Berlin, Germany. Construction work will be started at once and the plans contemplate the immediate completion of a section of the erection shop, and the light-car shop, the switch shop, service building and office building, and a part of the power plant. The works are situated at Homewood, a place about thirty-five miles from Pittsburg, and will make many of the products which have hitherto been imported by the Arthur Koppel Company from Germany. H. A. Ellis will have charge of the new works and is now arranging for the building of the plant. He has established an office at 1771 Frick Building Annex, Pittsburg, Pa.

FRANK B. COOK, Chicago, Ill., has issued an interesting pamphlet calling attention to Cook's type B-4 subscriber's station protector. The type B-4 protector is equipped with Cook's new tubular fuses, with improved carbon lightning arresters, and with sensitive heat coils. All parts are mounted on a heavy porcelain base. The fuses protect against heavy currents. The improved carbon lightning arrester is provided with a perforated celluloid dielectric, in which the perforations are so small and so numerous that the discharge is greatly broken up, and is forced to pass through the arresters at many points. If an arc continues, the celluloid melts and the carbon blocks are pressed together by springs, forming a dead ground through the arrester. The pamphlet contains reports of a number of cases where disastrous accidents might have been avoided if proper protective apparatus had been employed.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., announces that, following the recent starting of the 5,500-kilowatt steam turbine and generator unit at the Williamsburg power-house of the Brooklyn Rapid Transit Company, Allis-Chalmers turbines have been put practically in readiness for starting at the power-houses of the New York Edison Company, Bronx station, New York city; West Chester Lighting Company, New Rochelle, N. Y.; Dayton Lighting Company, Dayton, Ohio, and the Brooklyn Edison Company, New York. The general interest which has been manifested by the engineering fraternity in the development of the Allis-Chalmers turbine has been stimulated by the showing made at the starting of the Williamsburg unit. The successive initial performances of the Allis-Chalmers units enumerated above, now ready for service, and only awaiting completion of auxiliary equipment before being started, will be watched by engineers and those interested in power production everywhere. A 1,500-kilowatt unit for the Memphis Consolidated Gas and Electric Company of Memphis, Tenn., having just undergone satisfactory test at the West Allis, Milwaukee, works, is now being prepared for shipment. Similar tests on three 500-kilowatt units, two for the city of Jacksonville, Fla., and one for the Western United Gas and Electric Company of Aurora, Ill., will follow as rapidly as possible, after which the three 1,500-kilowatt units ordered by John I. Beggs, to meet unusual running conditions, will be rapidly brought to completion. These latter units are for installation in the handsome new station of the Milwaukee Electric Railway and Light Company, Milwaukee. The construction of steam turbines by the Allis-Chalmers company, which has up to the present time been seriously handicapped for want of necessary space and working facilities, will very soon be transferred to the new turbine shop in unit No. 4 of the West Allis Works, which is rapidly nearing completion and which will be devoted entirely to the construction of this type of prime mover.